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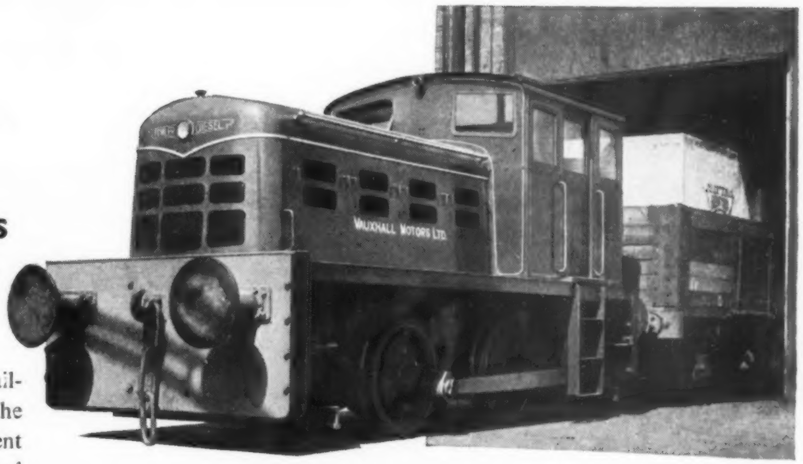

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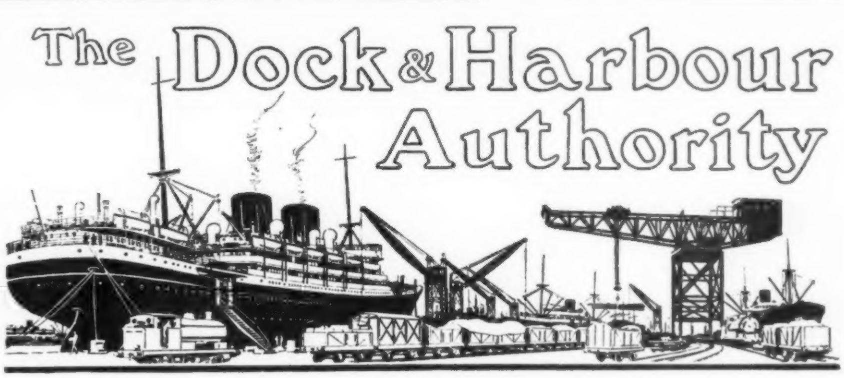

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The Dock & Harbour Authority

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No. 390

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Editorial Comments

The Port of Preston.

Although it is difficult to trace its exact origin, the Port of Preston, situated on the River Ribble, can lay claim to Saxon antiquity. It was undoubtedly a town of importance prior to the Norman conquest, for records exist which show that William I granted it to Tostig, a son of Godwin, Earl of Kent. The first of its fourteen royal charters was granted by Henry II, who conferred upon the town the same privileges that had been given to Newcastle-under-Lyme, including a free borough and a merchant guild. Then in 1566 Elizabeth I granted the town its great charter which ratified and extended all previous grants.

Woollen weaving and the manufacture and export of linen cloth were two of the early trades of the town, the latter, however, being displaced in the 18th century by cotton goods. Preston's importance progressively increased after the advent of the cotton trade so that to-day the industries include engineering, iron and brass founderies, cotton machinery manufacture, chemical and soap works, boiler works and shipbuilding and ship repairing works.

Preston became an independent Port in 1843, and since that date has been progressive in increasing the depth of the seaward channel and in the building and improving of docks and quays. The rise and development of the Port as one of the few notable ports between Swansea and the Clyde, a position which it owes to its central situation as an outlet for Lancashire and West Yorkshire, is the subject of our leading article this month. As the author points out, Preston is to some extent overshadowed by the much larger ports of Liverpool and Manchester, but in spite of this the port has steadily progressed, and the figures for 1952 show a remarkable increase over previous years in the totals of imports and exports.

The conception and construction of the Ribble training walls in spite of great regime and topographical difficulties has constituted a major achievement in tidal river training works.

Readers will observe in the article many points of interest, a post-war development of note being the ferry service with Ireland, in which sealed containers and traders' own lorries are used.

An Uncertain Future for British Transport.

The Transport Bill, in the form in which it has left the House of Lords, has benefited from many amendments; it still remains essentially a two-part measure, firstly to dispose of publicly-owned road haulage and secondly to promote the reorganisation of publicly-owned transport—rail, certain road services, inland waterways and certain docks. The Transport Commission is required to prepare a scheme for this reorganisation, with increased regional autonomy. The scheme is to be submitted to the Minister within twelve months, and must include the abolition of the Railway Executive. Apart from this requirement, the terms of reference under which the Commission must draw up its proposals were admitted by Viscount Swinton to be very vague. Whether this means that the Commission will really have a free hand remains to be seen. Thus, although it is clear that the Commission will only control the Ports which it already operates through the Docks and Inland Waterways Executive, the future organisation of these ports and even the independent existence of the Docks and Inland Waterways Executive are uncertain.

One disquieting feature is the lack of any specific statement of policy towards canals and canal-carrying activities, and it must be remembered that the Commission only owns about a quarter of the carrying fleet; hence the commercial canal-carrying organisations and their employees must once more be facing unrest and uncertainty, similar to that which accompanied the changes consequent upon the 1947 Act.

One proposal, which seems to be regarded as acceptable and even probable, is that the existing Inland Waterways Divisions of the Docks and Inland Waterways Executive should be directed by the Regional Transport Managers, whose main interest will be railway operation. Such an arrangement would, in our view, be disastrous to the future of inland waterway transport, and wholly contrary to the public interest. It would be paradoxical if a measure, the alleged object of which is to give to the public any benefits which may arise from more intense rail-road competition, should result in frustrating and suppressing such enterprise in inland water transport as has been evident under the present organisation. It would be intolerable if those responsible for running such canals as the old Grand Union, which for over a century have survived and retained their integrity, should be confronted with the discovery that their new masters are none other than their most bitter competitors.

British Inland Waterways.

Meanwhile, as reported on a later page, a lecture at the Royal Society of Arts by Mr. R. F. Aickman of the Inland Waterways Association has served to draw attention to the problems facing inland waterways. Mr. Aickman does not, of course, profess to express opinions on behalf of trade and commerce, but his lecture stimulated discussion and interest, both at the time and in the Press. During the spoken discussion, Sir H. Osborne Mance put in an authoritative word, giving support for a progressive and courageous canal policy, which would aim eventually at extending considerably the facilities for boats of economic size. Such a policy must be accompanied by the diminution of narrow boat traffic; probably such an eventuality, and an end to the working of "painted boats" by families living on board would not be welcomed by those who are fascinated by the more romantic aspects of narrow canal working.

However, whilst we are not distressed at the prospect of change in the canal pattern, we cannot agree with opinions voiced elsewhere that the only thing to hope for, because the canal industry is moribund, is the closing of all but a few estuarial navigations, especially if those which remain are to be dominated by railway interests. On the contrary, the difficult problem of waterways with little traffic potentiality must be tackled, in conjunction with their use for water supply, drainage and amenity, so that they are no longer a burden to those which are busy or can be developed for traffic.

But, although we have argued that the Docks and Inland Waterways Executive should be freed from responsibility for these little used waterways, that is not to say necessarily that they should be closed, and our proposals are very different from the abandonment of all waterways, except those few which are now especially busy and profitable.

Editorial Comments—continued

Formation of an Inter-Governmental Maritime Body.

It was recently announced that eleven governments have taken formal action towards establishing an Inter-governmental Maritime Consultative Organisation—an agency that would promote international co-operation in maritime navigation, encourage maximum use of safety measures at sea, and seek removal of shipping restrictions and discrimination.

The proposed Organisation, which will be under the auspices of the United Nations Transport and Communications Commission, will be established when its Convention, drawn up to 1948, has been ratified by 21 states of which seven shall each have not less than one million gross tons of shipping. So far, the Convention has been ratified by Canada, France, Greece, The Netherlands, the United Kingdom, the United States, Australia, Belgium, Burma, Ireland and Israel, the first six countries meeting the requirement of 1,000,000 gross tons of shipping. A number of other governments have informed the United Nations that they are considering ratification.

It will be recalled that the Economic and Social Council of U.N., at its 11th session, stated that early establishment of I.M.C.O. was desirable, as the absence of an inter-governmental organisation able to deal with maritime questions has been publicly regretted many times by other organisations because it prevented joint action on many urgent matters. The new International Convention on Safety of Life at Sea, which came into force in November, 1952, also assigned important duties to I.M.C.O. and until I.M.C.O. begins operation, interim arrangements are necessary.

In the field of safety at sea, co-ordination of work by aeronautical, telecommunications, weather-reporting and maritime organisations is very desirable. So far, specialised U.N. agencies exist for the first three types of work (the International Civil Aviation Organisation, the International Telecommunication Union, and the World Meteorological Organisation), but the absence of an inter-governmental maritime organisation means there is at present a missing link in the chain of activities.

In other fields, too, co-ordination has been difficult because of the lack of a maritime organisation. For example, in preparing new International Sanitary Regulations, the World Health Organisation wished to consult shipping interests through an inter-governmental body, but this was impossible, as I.M.C.O. was not functioning.

Tidal Model Experiments in India.

In these days of scientific research into problems affecting the well-being of maritime transport there has been great development of reduced model experiments, and it is with interest that we learn that Mr. Joglekar, Director of the River Research Station, at Kadavasla, India, has explained to the National Harbour Board the progress so far made by the model experiments of the Ports of Cochin, Madras and Mangalore. He also detailed the much more difficult problems being investigated in the River Hoogly. He says " The Central Government very much appreciated the magnitude and importance of the various problems successfully tackled by the station and therefore took it over from the Provincial Government in 1937. Ten years later in 1947 they further expanded the activities of the station The expansion has progressed along the lines of the great experimental stations of Europe and America so that we now have new branches of research of great value to the technical professions; they include navigation, soils and soil mechanics, statistics, mathematics and physics. All of these new departments have been supplied with modern equipment."

The difficulties that have been encountered in the Madras and Cochin harbours are now being investigated by reduced models which have been built up with great care by the staff. The models of the Hooghly estuary and Mangalore port are now being utilised to seek means and methods to improve the navigation of these busy waterways in the most economical way. Mr. Joglekar also informed the Board that the Government has sanctioned the estimates for conducting similar experiments for the port of Kandla and the data for the model construction has already been undertaken.

The question of obtaining technical assistance from abroad was also discussed and the Board was informed that the Government of Bombay have already set up a marine survey unit of their own, but the Government of India have been requested to secure the services of a hydrographic expert through the United Nations Technical Assistance Administration to advise upon the hydrographic surveys of the smaller ports.

Topical Notes

Modernisation of Liverpool Graving Docks.

The Mersey Docks and Harbour Board have started work on the first phase of a scheme to modernise certain of their graving docks. One 15-ton electrically-operated travelling crane will be provided at the Langton Graving Docks and two more at the Birkenhead Graving Docks. Compressed air supplies, salt water mains and augmented electrical facilities including portable welding transformers, will also be installed at these docks at a total approximate cost of £456,000.

In order to provide for the capital commitment on the expenditure involved, the graving dock rates have been increased by 20 per cent. as from the 2nd April, 1953, the Minister of Transport having agreed to the proposed increase.

These improvements follow long consideration of the problem by a Sub-Committee which was set up by the Board in 1944 and the subsequent recommendations of a Working Party appointed after the meetings held in connection with unemployment in Liverpool in the ship repairing industry. The Mersey Ship Repairers' Federation have been consulted and this is the first stage in the Board's efforts to give the most modern facilities for all types of ship repair work at their graving docks.

Panama Canal Improvement Scheme.

An ambitious plan to improve the Panama Canal within the next 10 years, so that this important Atlantic-Pacific waterway can handle more ships, was announced recently. The directors of the Panama Canal Company said that the plan, which is estimated to cost $26,000,000, would be partly financed by tolls from ships passing through, and would substantially increase the capacity of the canal at relatively low cost.

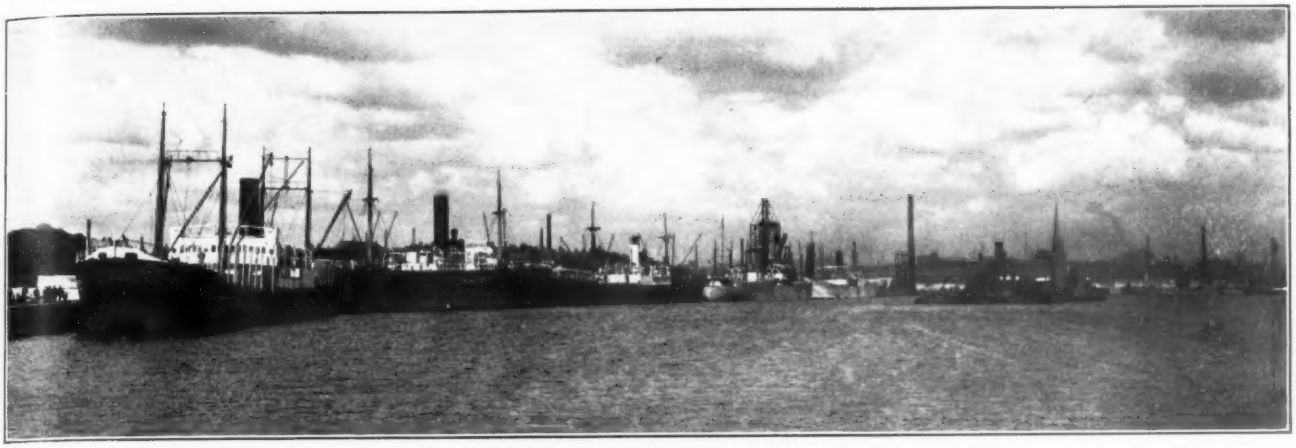
The United States Congress has first to approve the proposals, which are primarily modifications to avoid delays to traffic while locks are under repair. It was stated that at present necessary overhauls to locks affected the working of the canal for five months in every two and a half years. The improvements planned will limit the periods when delays may occur to not more than seven days at 30-month intervals. The directors emphasised the fact that the proposed improvements will not enable the canal to handle larger vessels.

If approval is given it is expected that the first phase of the project will be completed by 1956 at a cost of $1,500,000. The second phase, to cost possibly $25,000,000, will take about 10 years longer.

Port Schemes for Northern Ireland.

Schemes for the improvement of the shipping and fishery harbours of Northern Ireland, which are estimated to cost over £580,000, were outlined by the Minister of Commerce recently. After referring to the £101,000 scheme in progress at Portavogie Harbour, which it was calculated would take about two years to complete, the Minister said that on the Kilkeel Harbour scheme agreement had also been reached with Down County Council and tenders had been invited for the carrying out of the first part of the scheme, including the deepening of the entrance channel and the strengthening of the piers at an estimated cost of approximately £100,000.

The Newry and Larne schemes would continue during the present year and a contract had been placed by the Londonderry Harbour Commissioners for the carrying out of a major improvement scheme at that port. The plan included the reconstruction of an existing wharf, the construction of a new extension wharf and the provision of storage sheds. This was estimated to cost approximately £250,000 and to take some three years to complete. A scheme for the improvement of Coleraine Harbour had also been approved during the past year.



Timber Vessels alongside Albert Edward Dock, Port of Preston.

The Port of Preston

Progressive Harbour in the Ribble Estuary

By A. E. CORLETT, M.Eng., A.M.I.C.E.

The County Borough of Preston with its charters going back to the year 1100, has had a long and honourable history and has been associated with many of the important and critical events in the nation's life. Standing, as it does, on the west coast route between the South and Scotland, for both road and rail traffic, it serves as a strategic centre for commerce and communications. Well known as a main line station and junction on the Euston to Glasgow service, Preston has also a network of roads and railways connecting it with all parts of Lancashire and Yorkshire. A vast population lives in East Lancashire and Industrial Yorkshire, and the industries concentrated there form an important economic hinterland to the West Coast Ports. With this background it was only natural that Preston, standing on the River Ribble at the head of a wide estuary, should look to the sea and seek a share of the seaborne commerce created by the industries of the populous counties already mentioned.

The Ribble estuary has been navigated from early days but the ships were small and the navigation hazardous. Shifting, unmarked channels which altered with every violent gale must have made the sail to Preston difficult and dangerous in anything but the most moderate of weather. But the town of Preston offered a quiet haven and a trade centre so well placed that the demand for better facilities became more clamant and persistent. Certain local landowners formed themselves into a Ribble Navigation Company, and in 1806 obtained an Act of Parliament enabling them to put up "visible marks along the channels of the estuary." However, being landowners whose land bordered the Ribble, the Company was more interested in reclaiming land than improving the navigation to Preston, and shipping languished. The Merchants of Preston became more vociferous in their demands for better facilities to be offered to ships and another company was formed in 1838.

This company engaged Messrs. Robert Stephenson and Son of Edinburgh as their consultant engineers who recommended the employment of a "dredging machine" of the power of twelve horses, and in 1840 a small bucket dredger commenced work deepening the river channel. At Preston Quays there was only a depth of six feet of water on Spring tides, while Neap tides did not reach the quays at all. Not only was dredging required, but some stability had to be given to the winding and shifting channel and this was done by building low parallel training walls of rubble stone. The combination of dredging and training the channel, quickly led to an improved navigation and increased trade, and these principles have been followed throughout the years in securing a stable and navigable channel through the broad Ribble estuary up to Preston.

The interest of the Corporation of Preston in the port goes back to ancient times, and an oar forms part of the Corporation's regalia. But though the Corporation owned quays and warehouses and held shares in the Ribble Navigation Company from the early 1800's, it was not until 1883 that the Corporation felt that they should own and administer the port, and in that year they purchased the undertaking from the Ribble Navigation Company for the sum of £73,000.

The need of a wet dock at Preston had been felt for a long time and various schemes had been suggested but nothing had been done. However, when the port passed into public ownership, the construction of an adequate dock was pressed forward, and in 1892 Preston Dock was opened by H.R.H. the Duke of Edinburgh.

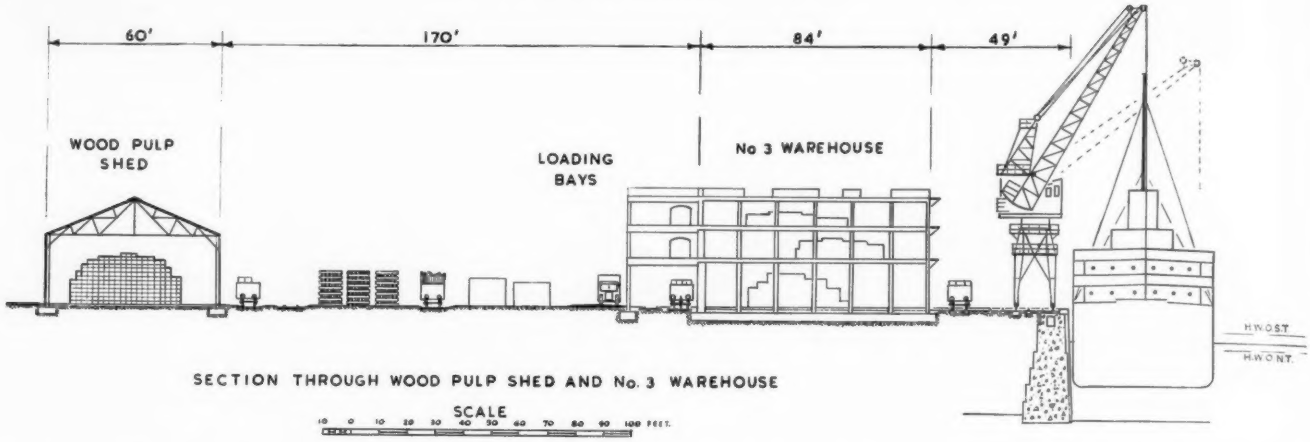
The Dock.

The Ribble was diverted for about a mile to allow the construction of the dock, and entrance into the dock from the river channel is at the west end of this diversion. The dock is quite a large one, rectangular in shape, with a water area of 40 acres. There is in addition a tidal basin of $4\frac{3}{4}$ acres. There are four pairs of greenheart timber dock gates, the first pair controlling the entrance from the channel into the tidal basin, the other three pairs form one large lock of 550-ft., or two smaller locks of 225-ft. and 325-ft., connecting the tidal basin with the dock. The width of the entrance and of the locks is 66-ft. The dock walls are of massive concrete gravity construction, with the cope 40-ft. above the dock floor. The gates are worked with hydraulic power generated at either of the two power stations on the dock; both stations are equipped with electrically-driven centrifugal pumps.

Dock land surrounding the dock amounts to some 170 acres, and provides extensive storage ground for timber, pit props, and woodpulp, which are imported through Preston in large quantities. Both open and covered storage facilities are provided and these are all near the quays. Warehouse accommodation is available for other goods, one being given over entirely to the handling of china clay, mainly used in the paper making and paint manufacturing industries situated near Preston. Four warehouses stand along the south side of the dock, and another one used as a transit shed stands at the east end where general cargo to Ireland is mainly handled.

Along the South Quays are placed modern electric level-luffing cranes lifting up to six tons, together with hydraulic level-luffing cranes and with three dockside rail tracks between the quayside and the warehouse;

The Port of Preston—continued



SECTION THROUGH WOOD PULP SHED AND No. 3 WAREHOUSE

SCALE

goods are rapidly sorted to marks and loaded to rail as required. At the east end of the South Quays is a large grain silo fitted with pneumatic discharging equipment; while at the other end of these quays are the china clay berths; here discharge from ship, when possible, is done by grab into hoppers, which after weighing, dump into storage bins according to grade and type.

Three coal tips, mainly loading coal for shipment to Ireland, stand on the north side of the dock, and are in constant use; They are operated hydraulically, and the most modern of these can load 400 tons per hour. There are also four level-luffing electric cranes mainly used in the discharge of timber, while at the north west quay a 15 ton electric level-luffing quayside crane is being erected to handle container and trailer traffic going to Ireland on the ferry service operating between Preston and Larne and Belfast.

Ferry Service with Ireland.

This type of traffic has developed extensively since the war and is proving very convenient for those merchants dealing with Ireland. Goods can be packed in sealed containers at the manufacturers' works in England and the goods arrive intact at the wholesalers' depots in Ireland. Pilferage losses are eliminated entirely, and damage to goods in transit reduced to an absolute minimum. Handling costs in addition are considerably reduced. In addition to the shipment of goods in containers, manufacturers' or traders' own lorries are used extensively for carrying products to Ireland. The lorries are driven on to the ship at Preston over a vehicle loading ramp, the driver travels with his lorry, drives it off at Larne or Belfast and distributes his goods at their destination. Again, losses from pilferage are cut out, and damage from handling, etc., is nil. The advantages are obvious, and this type of traffic has expanded considerably in recent years. A further development has been the introduction of trailers. Road trailers with their load form a unit which is road hauled to Preston by a motive unit, the trailer is loaded on to the ship, off loaded in Ireland, hitched behind another haulage unit, and taken to its destination. Irish traffic to Preston, of course, is handled in the same way.

Vehicle Loading Ramps.

At present one vehicle loading ramp is in operation at Preston whereby lorries, cars, etc., run off the quay in through the bow doors of the ferry steamer, but plans are well advanced for the construction of another loading ramp at an adjacent berth. This ramp will consist of a movable bridge span supported within the dock wall at one end and carried partly on the dock wall and partly on a dolphin at the other end; this end will be raised or lowered to suit the trim of the ship and variation in the dock water level.

Both berths are adjacent to a large vehicle parking ground and to one of the dock entrances, and are also served by rail sidings adjacent to the quayside.

The dock rail system is directly connected with the London Midland Region main line at Preston Station about half-a-mile distant from the dock, and with extensive sidings on the dock, rail traffic is easily and quickly marshalled and despatched. There are three road entrances on to the dock estate, well spaced out to cover the main quays and storage grounds, and as Preston is a road centre for both north and south traffic as well as east bound traffic, there are no difficulties or delays associated with goods carried by road. This of course in an increasing traffic, fostered by the growth or road transport generally and the ferry service to Larne and Belfast.

Shunting on the dock is carried out by the Port Authority's own locos, the majority of which are steam saddle tankers, but one diesel electric loco is operated, and for shunting in petrol yards a steam fireless loco is worked. For handling goods such as timber and woodpulp by road to stacking grounds, pneumatic tyred tractors and trailers are used and have proved very versatile and flexible.

The Tidal Basin.

The tidal basin apart from its primary function as a levelling basin, is used for the discharge of coasters bringing road stone aggregate from North Wales, handled by grabs attached to mobile diesel or steam cranes. On the north side of the tidal basin petrol and oils are discharged to storage tanks in the oil depots. Preston being a good distributing centre, this depot serves a wide area by road tanker. Whereas before the war refined oils came to Preston in deep sea tankers, due to the erection of refineries in Britain, the main trade is now with coastwise tankers operating from these refineries.

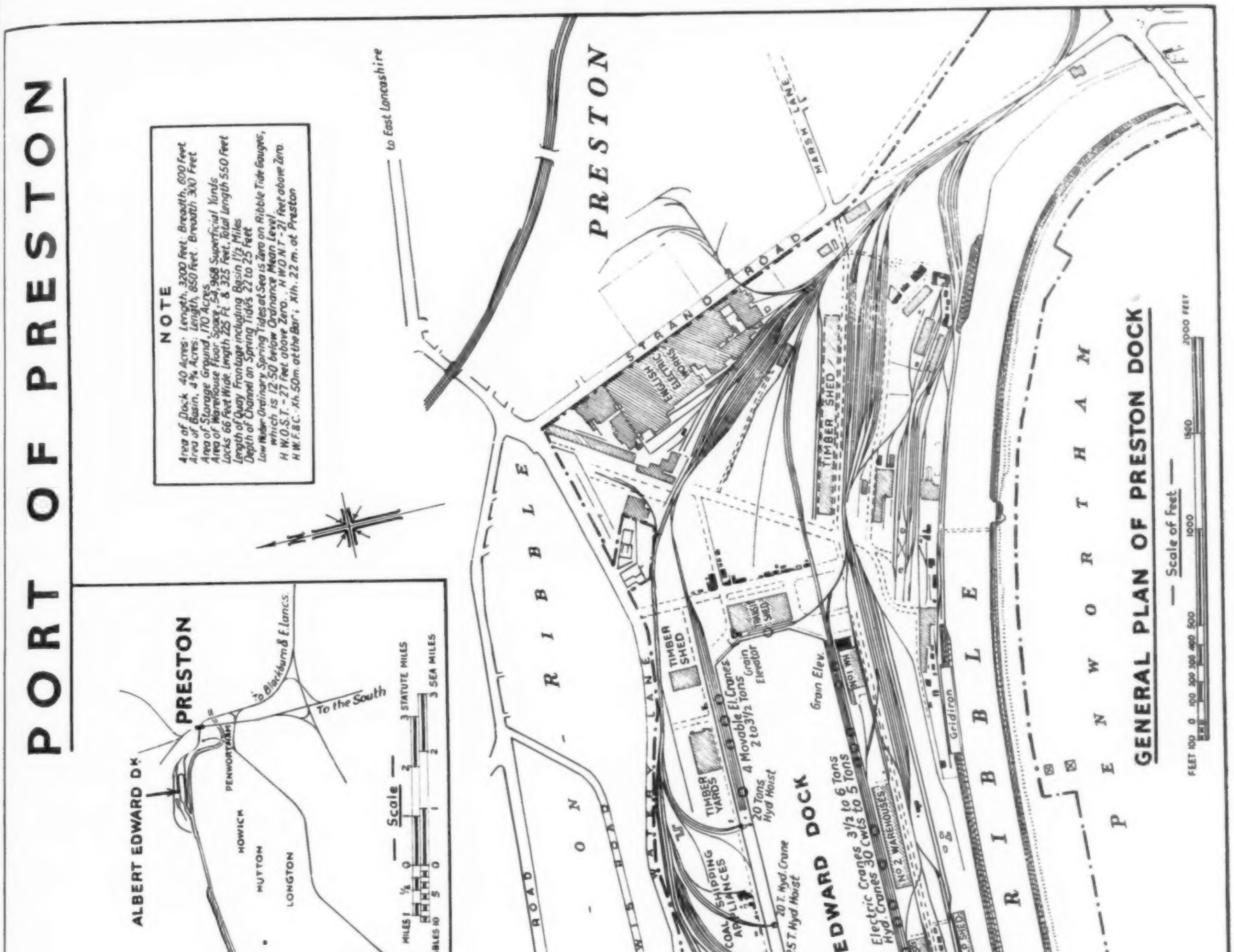
The usual services are available on the dock. Hydraulic power is supplied from the Authority's two electrically-driven pumping stations. Electricity is supplied direct by the B.E.A. from their Ribble generating station which faces the dock across the river. Coal for this station is handled over the dock sidings to a coal conveyor spanning the river. For this power station the dock is used as a cooling water pond, water from the dock passing through tunnels placed below the river bed.

The Estuary and Channel.

The Ribble estuary is funnel-shaped and projects into the Bay of Lancashire. Like all rivers falling into this bay, the mouth is encumbered with large areas of sandbanks. Through these sandbanks, the Dee, the Mersey, the Ribble, the Wyre, and the Lune make a channel to discharge their waters into the Irish Sea. These channels wandered at will among the vast sandbanks, and the fixing of a permanent path for the channel became a necessity for safe navigation. On both the Ribble and the Mersey, extensive and costly training walls have been built, and a stable fixed channel has been obtained. On the Ribble a training wall built of rubble stone extends from the dock a distance of 15 miles on the south side of the channel, and for 13 miles on the north side. Between these walls runs the main flood and ebb tidal streams, and the energy of these streams is utilized along this channel to maintain a section appropriate to the volumes of tidal and land water.

Ribble Training Walls.

Work was first commenced on the Ribble training walls in 1840 and has proceeded section by section ever since. Generally the walls are built with a clay heart faced


PORT OF PRESTON
NOTE
Area of Dock 40 Acres: Length 3200 Feet; Breadth 600 Feet
Area of Basin 4¾ Acres: Length 850 Feet; Breadth 300 Feet
Area of Storage Ground 170 Acres
Area of Warehouse Floor Space 54,968 Superficial Yards
Locks 66 Feet Wide, Length 225 Ft. & 325 Feet, Total Length 550 Feet
Length of Quay Frontage including Basin 1½ Miles
Depth of Channel on Spring Tides 22 to 25 Feet
Low Water Ordinary Spring Tides at Sea is Zero on Ribble Tide Gauges, which is 12.50 below Ordnance Mean Level.
H.W.O.S.T. - 27 Feet above Zero. H.W.O.N.T. - 21 Feet above Zero
H.W.F.&C. - XIh. 50m. at the Bar; XIh. 22m. at Preston
THE RIBBLE & ITS ESTUARY
FROM PRESTON DOCK TO THE SEA
PRESTON
ALBERT EDWARD DK.
To the South
PENWORTHAM
HOWICK
HUTTON
LONGTON
FRECKLETON
WARTON
HUNDRED END
CROSSENS
LYTHAM
ST. ANNES ON THE SEA
SOUTH SHORE
BLACKPOOL
SOUTHPORT
BIRKDALE
H.W.O.S.T.
Salters Bank
Horsebank
Angry Brow
Foulnaze
L.W.O.S.T.
2 Fathoms
3 Fathoms
IRISH SEA
PORT BOUNDARY
Scale
STATUTE MILES
SEA MILES
to East Lancashire
PRESTON
STRAND ROAD
MARSH LANE
ASHTON - ON - RIBBLE
EGERTON ROAD
PORTWAY
TIMBER SHED
TIMBER YARDS
COAL SHIPPING APPLIANCES
ALBERT EDWARD DOCK
4 Movable El. Cranes 2 to 3½ Tons
Grain Elevator
Grain Elev.
20 Tons Hyd Hoist
20 T. Hyd Crane
25 T. Hyd Hoist
7 Movable Electric Cranes 3½ to 6 Tons
7 Movable Hyd. Cranes 30 Cwts to 5 Tons
NO. 2 WAREHOUSES
CHINA CLAY SHED
15 Tons Movable Electric Crane
Gridiron
BASIN
Oil Discharging Berths
RIVER RIBBLE
PENWORTHAM
GENERAL PLAN OF PRESTON DOCK
Scale of Feet
2000 FEET

The Port of Preston—continued

with rubble stone placed from barge, the clay being dug by bucket dredger from the river bed and the stone brought by canal barge from Parbold. Later sections of the walls however consist of a clay mound covered and blinded with large shingle, also dredged from out of the river. A certain amount of wastage and settlement occurs and has to be made good from time to time, particularly on the lengths subject to erosive wave action.

The general direction and alignment of the trained channel was fixed by a commission appointed in 1891 who had to decide on which channel, of the then three channels through the sandbanks of the estuary, should be fixed and trained. They decided on the central one as being the most suitable, and subsequent developments have shown the correctness of their choice.

The trained channel is 200 feet wide at the bed near the dock and increases in width until at 13 miles it is 1,400 feet wide. The tidal range on ordinary spring tides is 27-ft., and on equinoctial springs 30-ft. This large range induces strong tidal currents, which in turn cause quite vigorous movements of sand in the estuary and channel. Artificial accretion and land reclamation of salt marshes were carried out for many years, but while natural accretion continues, artificial means of encouraging accretion have been discontinued, as it was realised that the preservation of the largest possible tidal reservoir in the upper estuary was essential for the maintenance of the channel. Unfortunately the dock was sited so near the tidal limit of the Ribble that an adequate tidal reservoir above the dock does not exist, and to remedy this deficiency extensive maintenance dredging has to be carried out.

Dredging.

The Port Authority possesses five suction hopper dredgers with a total hopper capacity of 4,800 cubic yards. All are self-propelled seagoing craft with triple expansion main engines. The two largest dredgers were built in 1948 and carry 1,400 cubic yards of sand which is loaded in about one hour; a separate totally enclosed pumping engine is installed in these ships, but in the three others the main engines are clutched into the propeller shaft when under way, and into the sandpump at the forward end of the crankshaft when the dredger is stationary and pumping is in progress.

In dredging, the suction pipe which faces forward is kept up to a face of sand by heaving on one or two main anchors which are pitched well forward of the working position. This type of stationary dredging results in a series of holes in the sandy bed of the river, but as the tidal currents, both ebb and flood, are fast running, the holes are soon levelled off by sand from adjacent areas. The dredged sand is carried out to a deposit ground at sea, and in the case of the two larger dredgers is then dumped by means of Lyster valves, which are hydraulically operated. The other three dredgers dump through ordinary bottom doors. One cargo is normally obtained each tide, but when dredging on the bar two cargoes are taken on a tide. Both day and night tides are worked.

In the early days of the port's history, extensive gravel and clay bars in the channel proved a grave obstacle to navigation and two bucket dredgers were employed for many years dredging these bars away and lowering the hard bed of the channel to a suitable level. This work was completed some years ago and only suction dredging of sand is now carried out. Due to the configuration of the estuary the flood tide currents have a velocity in excess of the ebb tide currents and there is a constant movement of sand from the lower reaches of the channel into the upper reaches. This eastward travel of sand is considerably lessened during the winter months when the ebb tide is reinforced by flood waters coming down the Ribble from the Pennines, but apart from the influence of this land water, the general movement of sand up channel has to be counterbalanced and checked by the dredging of the channel and the removal of the sand out to sea.

The dredging programme is designed to hold the channel at a level suitable for the type and size of the normal ship sailing to Preston. At present a ship drawing 22-ft. 6-in. can navigate the channel on ordinary Spring tides, the usual draft of ships using the port is 18 to 20 feet.

Towing.

Towing is undertaken by the Port Authority. Three tugs are maintained for towing duties in the channel and dock. A modern twin-screw diesel tug of 800 h.p. was commissioned in July, 1951, and has proved very successful and economical for the intermittent character of towage at the port. A single-screw steam tug of 550 h.p. is also maintained in continuous service, while a small steam tug is kept for standby duties.

Port Boundaries.

The southern boundary of the Port of Preston is the northern boundary of Liverpool, and Nelson Buoy which is the outer buoy for the port is $11\frac{1}{2}$ miles north of Liverpool Bar Lightship. The port extends from Formby Point to near the central pier at Blackpool about 16 miles in a north and south direction, and in an east and west direction about 23 miles from Nelson Buoy to the tidal limit of the Ribble. Nelson Buoy is about 4 miles west of the Ribble Bar and about 5 miles west of the commencement of the trained channel.

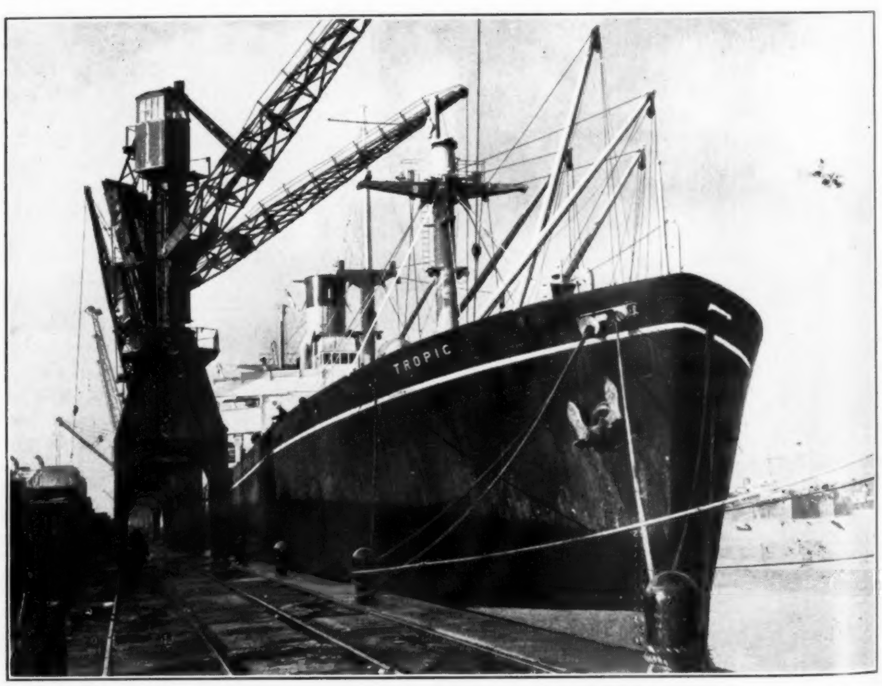
Administration.

The port is owned by the Corporation of Preston who annually appoint a committee to administer the affairs of the port. The committee consists of ten members of the Town Council; there are no co-opted members.

Trade of the Port.

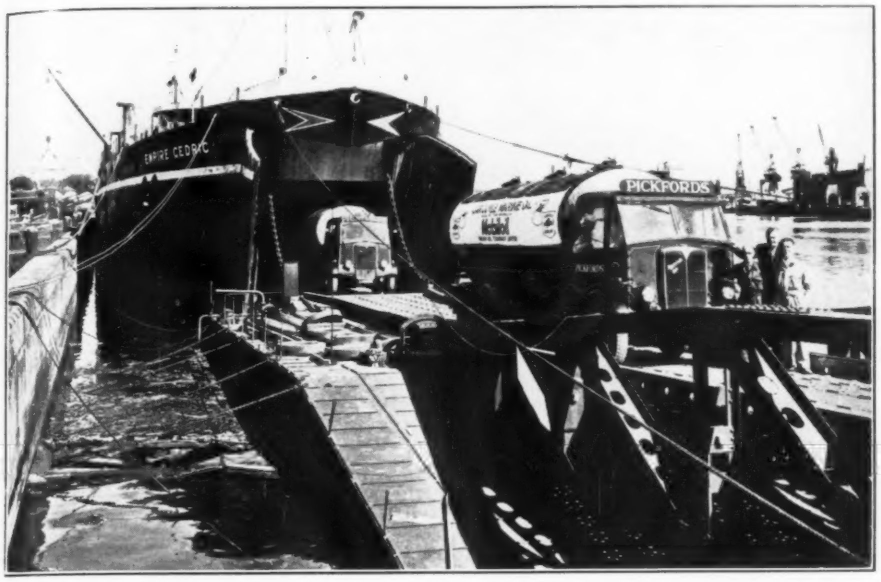
The Port of Preston, being situate approximately 30 miles from both Liverpool and Manchester, does perhaps tend to be overshadowed by these much larger ports, but notwithstanding the fact that it caters very largely for the same hinterland the development of the dock undertaking has steadily and continuously progressed.

By reason of the natural limitations of draft, Preston has not catered for the deep



Level-luffing cranes on South Quay, Preston Dock.

The Port of Preston—continued



Tank Lorries being loaded into Vehicle Ferry for shipment to Belfast.

sea regular line service, but has aimed at attracting the bulk cargoes such as wood-pulp, Esparto grass, paper, timber, china clay, pit props, stone and petroleum spirits. These continue to be the principal import commodities, but in the post-war years a considerable cross channel trade has been developed with Northern Ireland and Eire, and to-day there are 10 or 11 regular weekly sailings with Belfast, Larne and Dublin catering for general cargo. The principal export is coal to Ireland, amounting to over 500,000 tons per annum.

Preston is the English terminal for the transport ferry service carrying loaded vehicles and trailers between this country and Northern Ireland, and there are to-day five sailings per week each way. Another recent development is the commencement of a regular banana service from the Windward Islands, the service being a fortnightly one.

Preston is, in fact, one of the few ports which has made a rapid recovery from the immediate post-war slump, and is to-day handling a much greater volume of shipping than in the pre-war years, and the following figures will indicate the steady growth:

Year ending March 31st.	No. of Ships.	N.R.T.	Total Imports and Exports. Tons.
1893	537	48,821	94,142
1903	1267	204,568	505,796
1913	1478	284,740	738,713
1923	1557	408,788	847,830
1933	1401	549,788	843,787
1939	1466	550,418	971,583
1943	1104	332,471	681,610
1952	2136	1,018,060	1,223,747

British Inland Waterways, Today and Tomorrow

Review of Past History and Current Problems

At the Royal Society of Arts, on February 18th, 1953, Mr. R. F. Aickman delivered a lecture about the Inland Waterways of Great Britain. The chair was taken by Sir Gilmour Jenkins, Permanent Secretary of the Ministry of Transport, in the unfortunate absence of the Rt. Hon. A. T. Lennox Boyd, M.P., Minister of Transport, who had been expected to undertake that duty. Introducing the lecturer, the Chairman said that Mr. Aickman was known as a keen enthusiast in this sphere. "To any good civil servant," he said, "an enthusiast is a man to watch very carefully." He felt sure that the lecture would be worthy of consideration. He was, however, bound to disclaim for himself and his Minister any responsibility for what was going to be said.

Mr. Aickman is Vice-President of the Inland Waterways Association, and since most of those whom he was addressing were not conversant with the history and current problems of the waterways industry, he very properly outlined in the first place the objects of the Association and stimulated interest with a brief historical survey. Since, at a time when transport policy is being given so much thought and publicity, a knowledge of waterways affairs is regrettably scanty, it was particularly timely that interest should have been stimulated in this way.

Restoration of Every Navigable Waterway

"The principal aim," said Mr. Aickman, "of the Association is defined in its Constitution as being 'to advocate the use, maintenance, and development of the inland waterways of the British Isles, and in particular to advocate and promote the restoration to good order, and maintenance in good order, of every navigable waterway; and the fullest use of every navigable waterway by both commercial and pleasure traffic.' The Association is entirely non-political, and includes within its membership Members of Parliament of all parties. We do not so much care who owns the waterways; we do care that the owners maintain them in good order and operate them efficiently. Our members are drawn from the widest possible range of people, for, as I shall endeavour to show, the subject of waterways touches life at many different points." The speaker then referred to the effect upon the British canal system of railway ownership of a substantial minority of its mileage. One example quoted was that of the Kennet and Avon Canal, which might have become an important trade route from the Thames to the Bristol Channel, if events had occurred differently. "It has," said Mr. Aickman, "big locks, 73-ft. by 14-ft.; and it is a fine work of engineering by John Rennie, which passes through much lovely country. Clearly it should be reasonably busy. In fact it was acquired by the Great Western Railway in 1852. By 1906 the tolls for using it were described as being 50 per cent. higher than on any comparable waterway in the country. Fantastic regulations were enforced: fires were prohibited in moored boats, thus *literally* freezing out the boatman; and what was known as week-end navigation was stopped, thus depriving the trader of one of the great advantages of canal transport, and making the development of pleasure traffic almost impossible. By about 1930 there was no traffic at all on this enormous waterway, which was simply falling into ruin.

"For at least a hundred years, therefore, inland waterways, though with some very important and distinguished exceptions, have tended to be Britain's forgotten industry. There have been a number of abandonments; but, in general, it has been deemed injudicious to risk the opposition which large abandonment proposals would undoubtedly have aroused, and preferable to proceed by simply lying as low as possible about the whole subject, and doing everything to discourage traffic, in particular by neglecting the statutory obligation of good maintenance. For it must be emphasised that this obligation exists. Canals are normally constructed under Acts of Parliament which lay upon the undertakers the obligation to admit all craft of suitable dimensions and to keep the waterway in good order; and these obligations cease only when Parliament has agreed to the canal being abandoned. The Great Western Railway Company regularly stated in its Annual Report that the Company's canals had been maintained in good order, when latterly there was not a single one of them of which this could truly be said.

"Public opinion has never been entirely easy on the subject, however, and perhaps the most remarkable thing of all has been

British Inland Waterways, Today and Tomorrow—continued

the series of public enquiries of various kinds, the last of them as recent as 1942 (the late Frank Pick presided over it), which have unvaryingly recommended that the canals be in some way removed from the hands of the railways, and redeveloped in the national interest. What is remarkable about these recommendations is that no single one of them has ever been acted upon; anyway not specifically: a little has been done as a by-product of nationalisation."

The limited development of inland water transport in this country, compared with the European continent and elsewhere, was next emphasised, and this was ascribed largely to the effect of railway control of certain vital waterways, and to the parochial spirit in which the subject has been—and still is—approached. The British Transport Commission did not escape criticism in this and other respects, but the speaker did not venture any opinion upon the effects of the de-nationalisation proposals contained in the Bill shortly to be enforced. Nor did the speaker indicate any line of policy for the Transport Commission in its dilemma, which arises from a duty to operate profitably, whilst facing a desire to maintain the existing waterways system more or less intact.

The lecture continued with an outline of the recreational potentialities of the canals and the undoubted beauty of considerable lengths of them; in this respect the Docks and Inland Waterways Executive was congratulated upon its accommodating attitude towards pleasure boats on their canals.

Canals and Water Supply Schemes

In his survey, Mr. Aickman then drew attention to the relevance of water supply schemes in any consideration on the policy for waterways. "There is concern," he said, " in many parts of the country that the water table is falling, and that the demand for water is steadily outdistancing the supply. The suggestion that water be sold by meter has at last become serious and active. More to our point, vast sums are being expended upon the construction of new reservoirs which often put out of commission large areas of agricultural land. A scheme is in hand to water the town of Coventry by pumping water from the River Severn to the top of Bredon Hill (of all places). There is no doubt that much more use could be made of the existing inland waterways system; and even less doubt that new and wider canals could both carry large trading vessels into the heart of the country, and bring water to the towns from the rainy districts of Wales and the Pennines. A particularly ingenious scheme of this nature has been devised by Mr. J. F. Pownall*, who names it the Grand Contour Canal. Mr. Pownall demonstrates that a canal running along the 300-ft. contour line, and therefore needing no locks, would serve the most surprising number of populous districts in all parts of the country. It would, of course, feed water to, and be fed by traffic from, the existing waterways system and new branch waterways. Mr. Pownall's scheme has a reasoned adventurousness worthy of Brindley himself.

" This possibility of using canals for water supply brings me back to the urgent need for a wider view, for the widest possible view. There is a scheme under consideration for using another part of a canal I have already mentioned, the Welsh Section, as a means of feeding water from the River Dee into a reservoir near Nantwich. As the distance involved is about 40 miles, and as the canal in question is otherwise in danger of final closure, the scheme has much to commend it. But I mention it now because it seems to be taken for granted that if the scheme goes forward, it will be impossible to permit the waterway to be polluted by the passage of boats. With modern purifying plant, this surely seems excessively cautious; but the notion is typical of the strict departmentalisation which afflicts the waterways. For example, two Ministries additional to that represented by our Chairman are concerned with the subject; not only the Ministry of Transport, but the Ministry of Agriculture and the Ministry of Health also. There are major navigable waterways, bearing considerable traffic, with which the Ministry of Transport has almost no concern. The River Great Ouse is an example. And the Ministry of Agriculture, which *is* concerned, will tell you most frankly that it has no interest in boats or traffic, but is entirely preoccupied with the question of drainage. This view of the matter the Ministry has duly implemented on many waterways in Eastern England, such as the River Welland and the Brandon River by replacing the former locks by fixed stanches, and thus making a once navigable river into lengths of dead water.

" At this very moment it is proposed to spend millions of pounds on the Great Ouse catchment area, but the possibility of restoring the derelict locks on the upper reaches of the river, and thus making Bedford accessible by water as it used to be, is almost outside the Ministry's scheme of reference. The Docks and Inland Waterways Executive is similarly cramped."

Finally some details were given of the voluntary efforts on the part of waterways enthusiasts in the rebuilding of Linton Lock, reconstruction on the Warwickshire Avon and in enlisting public interest and action towards re-opening the Great Ouse to Bedford.

Discussion on the Lecture

In the subsequent discussion, contributions were made on a number of aspects of the subject. The lecturer was asked for figures on the estimated cost per ton-mile for transport by canal of various commodities, but he said that he felt it impossible to become entangled in this controversy on that occasion. He also commented upon the cost of restoration of canal works, and said that he was convinced that official estimates were often unnecessarily high and discouraging. One speaker believed that he could carry by water at charges about two-thirds of the railway rate. Brig.-Gen. Sir H. Osborne Mance, admitting that wider knowledge on the costs of canal operation was an urgent need, referred to the results of technical research on this subject, the conclusions from which led him to believe that we must think in terms of canals which would accommodate a pair of boats of 220 tons carrying capacity. The capital required—over £20,000,000—was not available now, but a plan and traffic investigation should have been started long since. Despite the inadequacy of precise data on costs, he was convinced that narrow boats could not be worked so as to provide a reasonable livelihood for the crews, without a liberal subsidy.

Sir Reginald Hill, Chairman of the Docks and Inland Waterways Executive, in some pertinent remarks, said that he would welcome a new approach to the problem of preserving the amenities and beauties of canals, no longer required commercially, with an end to recriminations. Whether the maintenance of those canals, retained as amenities, should fall on the shoulders of the transport user was, however, another matter. He reminded those present that about £7,000,000 had been spent over the last five years on maintaining and restoring main lines of canals.

In proposing a vote of thanks to Mr. Aickman, Sir Gilmour Jenkins said, " It has, I know, been a great pleasure to all of us to listen to Mr. Aickman, particularly when we did not agree with him, to hear from him the very interesting work which his Society is doing, and to hear also the success which has attended its efforts, particularly its success in attracting public interest as indicated by public money, which is much more difficult to obtain than interest."

Implications of the Lecture

In view of the grave risk that the new Transport Act will cause some disruption, unrest and uncertainty within the waterways industry, the publicity resulting from this paper is to be welcomed. Furthermore, it once more focuses attention upon the problem of little used canals, of slight commercial utility. Many would consider their abandonment as a tragedy, and such action is in any case fraught with difficulties; on the other hand revenue, including that from pleasure traffic, lags sadly behind the expenditure even upon inadequate maintenance. Perhaps the solution is to be found by voluntary Associations, such as that for which Mr. Aickman spoke, actively taking increased responsibility for those little used waterways. A Corporation, like the Transport Commission, which must be expected to direct its affairs along business-like lines, cannot be expected to meet the costs of maintenance of waterways, for whose existence the justifications are their beauty and their amenity value, the part they fill in drainage schemes and their use as water conduits. The disposal of these waterways, categorised in the 1951 Transport Commission Report† still remains as a most urgent task for those concerned with transport policy. Mr. Aickman's lecture may serve the country and the industry well by calling attention again to this important problem.

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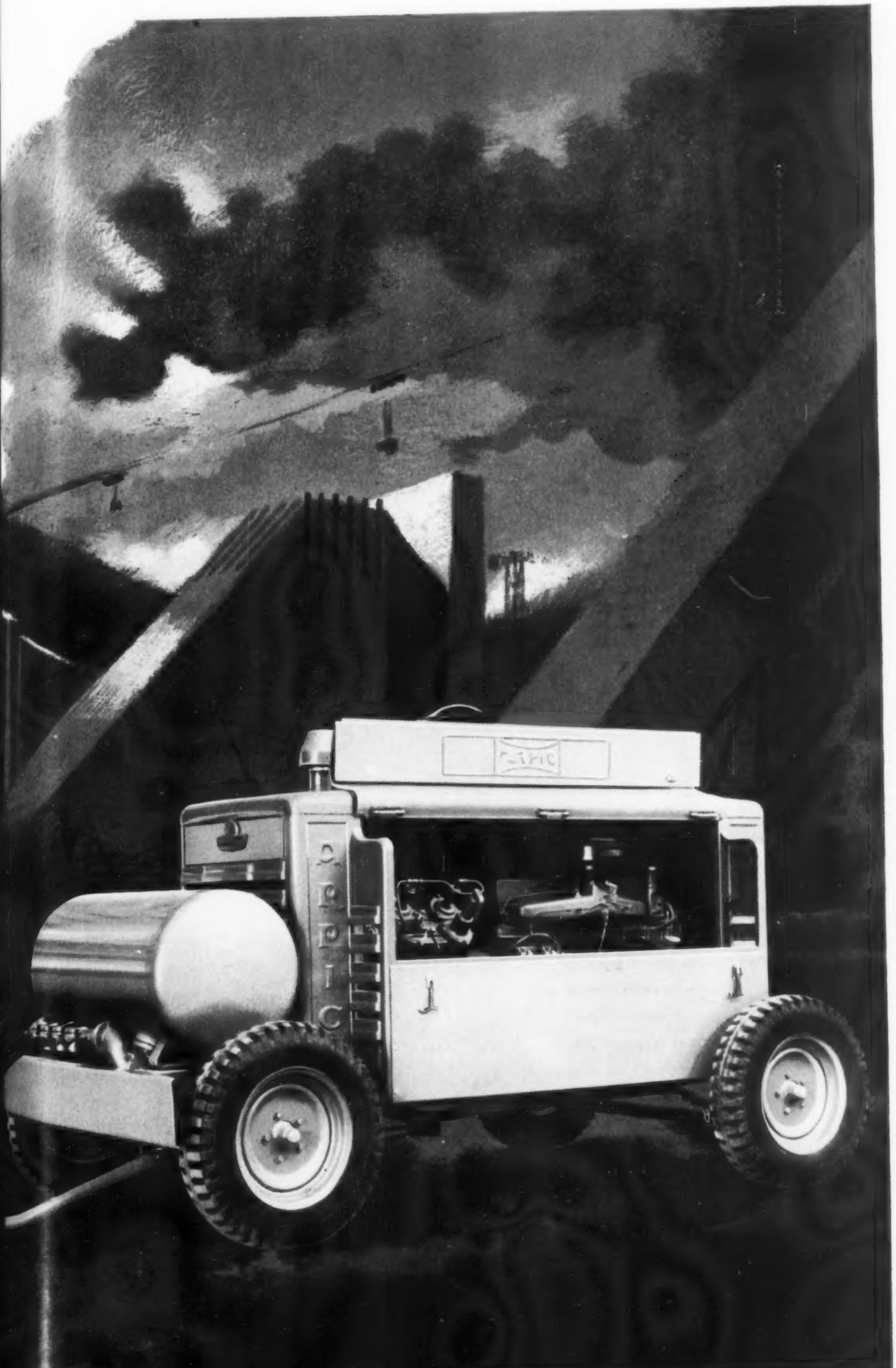
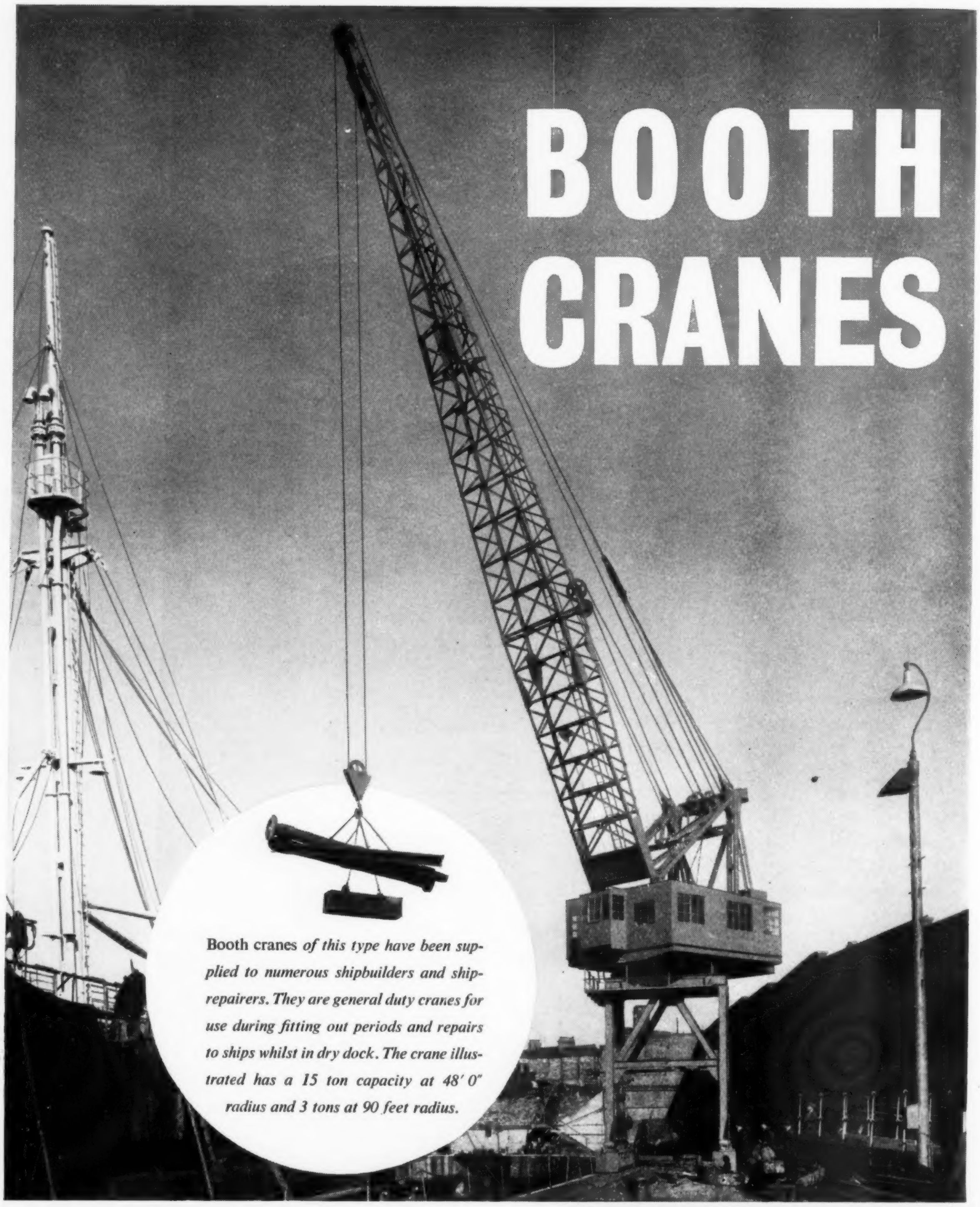
*See " The Dock and Harbour Authority " November 1951.

†See the Fourth Annual Report of the B.T.C. referred to in " The Dock and Harbour " August 1952.




BOOTH
CRANES
Booth cranes *of this type have been supplied to numerous shipbuilders and shiprepairers. They are general duty cranes for use during fitting out periods and repairs to ships whilst in dry dock. The crane illustrated has a 15 ton capacity at 48′ 0″ radius and 3 tons at 90 feet radius.*

The Use of Welding in Port Works

Some Varied Examples of its Application

By ROLT HAMMOND, A.C.G.I., A.M.I.C.E.

ONE of the most remarkable features of engineering technique in the last few years has been the development of welding, and this was very well brought out by the conference on welding as an aid to saving steel and man-power which was held at Ashborne Hill at the end of March, 1949. Although this is more than four years ago, yet we can derive much useful background information about the position of welding as a whole, the conference having been sponsored by the British Welding Research Association and the Institute of Welding; it was attended by more than 200 executives, engineers and designers, and was planned to extend knowledge of welding and possibilities for economising in steel and man-power by the wider application of the new technique. Papers were read on welding applied to shipbuilding, constructional engineering, railways and machine-tool production.

In the final session, the following was unanimously agreed: "This conference has considered the saving in steel and man-power that can be achieved by the application of welding in the above industries, and notes that considerable savings have already been achieved. A wider knowledge of these savings is essential, so that further economies could be readily effected by increases in the use of welding, and a more informed approach in the many fields in which it is now being used."

In all those branches of industry considered at this important conference, it was made plain that in order to achieve the fullest advantages from welding, designs must be prepared specifically for welding. Previous designs based on other practices, including casting and riveting, must not be slavishly copied. Full advantage should also be taken of automatic and semi-automatic welding processes, and steelmakers should be urged to roll special sections which would help in applying welding to better structural advantage. Continual efforts should be made to improve the quality of production welding, towards which the application of non-destructive methods of testing can make a significant contribution. Use of high-tensile steel of weldable quality should be extended, and steel of low notch sensitivity is an urgent requirement.

Serious structural failure of certain American welded ships built during the last war gave rise to much ill-informed opinion about these failures. The origin of the fractures which occurred was a combination of stress-raising errors in design, workmanship or material. It must also be remembered that these vessels were built in the open by very rapid prefabrication methods, and this fact must be borne in mind when considering these matters. The main point to be stressed is that modern welded structures are designed on a scientific basis, and the outstanding success of the modern all-welded ship—particularly the large all-welded tanker—shows what can be achieved by careful attention to detail and by thorough supervision aided by well trained men on the job.

As readers will be aware, the term "welding" embraces many forms but that all lie within two general categories—**forge** welding and **fusion** welding. The former includes the ordinary **blacksmith** welding and also electric **resistance** welding of several types, i.e. spot, seam, projection, butt and flash butt work.

Fusion welding is divided into three main groups, i.e. the electric arc, flame and "thermit" welding, the former being performed by the carbon or metallic arc and flame welding by oxy-acetylene or oxy-hydrogen, etc., gases.

Whilst all of these welding processes, except perhaps resistance welding, may have a place in dock and harbour engineering for various purposes, the principal form that we are now considering is that applied to structural steelwork. In this the process mainly employed is the metallic arc, the applications of which in maritime engineering are many, and we shall begin by considering the work done in what was known as "Operation Shark," because it is an excellent example of work properly planned and laid out to take full advantage of welded construction. This operation was planned by the War Office to ensure speedy rehabilitation of ports destroyed by enemy forces during the Allied advance into Northern France, when use was made of the sectional dock caisson. Much of the berthing accommodation being in wet docks, the speedy replacement of damaged dock gates was therefore of the utmost importance during that critical time, and these caissons were used for that purpose.

The scheme was based on the production of a number of identical steel tanks which could be bolted together to form one caisson, the number of tanks in the assembly being dependent upon the width of the dock entrance. Each unit was 40-ft. long by 30-ft. deep by 7-ft. wide. Seven units, for example, could be assembled as a 49-ft. wide dock gate impounding 28-ft. of water in a dock entrance with a width of 60-ft. The gaps between the ends of the caisson and the faces of the lock wall were closed by means of 14-in. timber flaps reinforced with steel hinged to the two upstream corners of the caisson. The seal to the underside of the caisson was made by the construction of a concrete and timber bed and thrust sill. Where the maximum permissible depth of 40-ft. of water was required, this could be achieved by attaching extra tanks and flaps 15-ft. high to the top of the main caissons. The 15-ft. flaps were provided with openings 5-ft. from the top to prevent the maximum depth being exceeded and the caisson rendered unstable.

In operation the units were towed to their destination on their sides. They were then stripped of their protective timber fendering and turned to their vertical position by flooding. The necessary number of units was trimmed to a predetermined fixed draft and bolted together side by side and two timber flaps were fitted at the corners. The complete caisson was then towed over the sill on slack high water and sunk in position by flooding. The dock entrance was opened about two hours or so before high water—the impounded water having previously been lowered through the sluices about two or three feet — by de-watering the caisson by compressed air, thus allowing it to be floated and towed to one side to permit passage of shipping.

The construction of various units was carried out at the works of several contractors and while fabrication was proceeding in various parts of the country, a site adjacent to a railway and a tidal river was selected and fitted out with railways, roads, reinforced concrete assembly areas, launching ways and fitting out berths, offices, stores, canteens and other services. Final fabrication and assembly of the caisson units was accomplished by 12 cranes up to 30 tons capacity and the necessary welding and other plant.

In order to suit welded fabrication, site assembly, transportation and other factors, it was decided to subdivide fabrication of the main tanks into 9 units. The base section of approximately 20 tons contained the valve-controlled sluice pipes and flooding valves and was delivered to the site as a single unit. All sides and partitions were prepared as sub-assemblies and then tack-welded together as a unit in an upright position. Each unit was then tilted four times through a right angle, allowing welding to be completed in one revolution. Internal ventilation, both in the shops and later at the assembly site, was carried out by means of extractor and forced-draught fans in combination with flexible ducting. The heaviest weld laid down was a 5/16-in. fillet.

As the tanks had to be of watertight construction, self-contained assemblies were subjected to a pressure test with compressed air at 10 lb. per sq. inch, using a soap solution as a leak detector.

The programme at the assembly site demanded the production of one main tank unit and one top tank unit per day, seven days a week, irrespective of tides and weather. A belt-conveying system was employed, the belt consisting of a reinforced concrete raft carrying a broad track along which the units were propelled from bay to bay for each successive operation. Tubular scaffolding was

The Use of Welding in Port Works—continued

arranged in tiers so that access could be gained to every square foot of area of tanks in every bay, the tiers being interconnected by sloping gangways, ladder access being thereby eliminated. This easy access was an important feature of the work, because it enabled all operations to be carried out under ideal conditions and greatly simplified that careful supervision which is always an essential part of any successful welded fabrication project.

On the arrival of the sections at the assembly site they were taken to the first bay of the production line and there erected, positioned and temporarily bolted together to form a 60-ton unit, 7-ft. wide and 40-ft. long by 30-ft. high, on an articulated eight-wheel bogey. On the morning of the second day, the unit was travelled along the track to undergo its second operation, that of welding, to make the sections into one homogeneous whole. On the third day, the units moved into the third bay, where all surplus metal was ground flush with the face of the tank to ensure that where adjacent units were bolted together they would impound the water. In the fourth, or drilling, bay a pair of master jigs was applied one to each side of the unit. Electric drills came into operation and drilled the holes to exact centres to ensure complete interchangeability. While the units were being processed in the second, third and fourth bays, specialised squads of erectors were fitting such items as valves, valve rods and wheels, suction and blow pipes, clack valves, screwed caps, internal access ladders, platforms, internal tool lockers and so forth.

The unit by this time was ready for testing in the testing bay. All valves were closed and the bulkhead and latch doors closed down, while the holes for bolting the units into caissons had been previously fitted on the inside of the tank with watertight screw caps. The test consisted of blowing compressed air into the tank at the aforementioned pressure of 10 lb. per sq. in., and this pressure had to be held for a specified time, leaks being revealed by the soap solution. In the painting bay the inside and outside of the unit were painted with anti-corrosive paint, followed by an external coat of anti-fouling camouflage paint. The seventh operation is illustrated in Fig. 1 and shows the unit being turned from the vertical to the horizontal position, in which it was launched and towed away. The specially designed turning cradle was used to swing the tank through 90° and to discharge it on to a bogey conveying it to the fender bay for the eighth operation, all in about ten minutes. Each unit was next heavily fendered with 14-in. timbers secured by quick-release fastenings. This timber not only served as protection for the units while being towed, but was also intended for use on arrival at the destination.

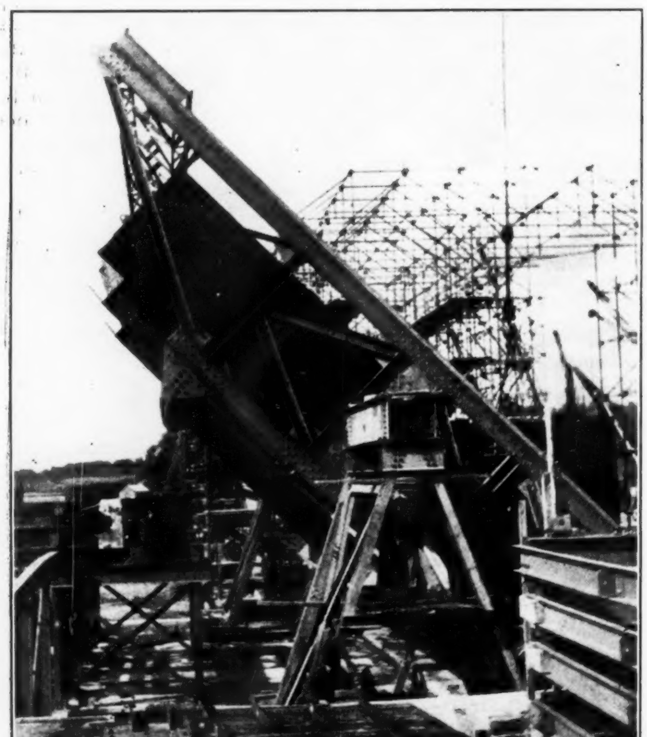


Fig. 1. Unit being capsized in the Turning Bay from the vertical to the horizontal position. To ensure absolute control the cradle was designed to be out of balance by 3 tons with or without the tank unit being in position.

Fig. 2. Beginning assembly ; segments being tack welded to flat skin plates.

From the above it will be seen that it took nine days for each unit to pass through the complete sequence of operations. The scheduled rate of one unit handed over each day was achieved after initial difficulties had been overcome. Deep-water moorings were laid in an adjacent estuary to which the units were towed as they were completed. The 15-ft. auxiliary top tanks were also handled in a similar manner to the main units on a parallel-belt system. The author has referred to this work in some detail, because it illustrates very well what can be achieved by carefully planned welded fabrication, and there is no doubt that many valuable lessons were derived from this work.

The whole of the equipment was planned, designed and produced under the general direction of Sir Bruce G. White, K.B.E., R.E., M.I.C.E., and its construction and assembly was undertaken by 16 contractors. While the whole of the work, both in the shops and at the assembly site came under the inspection of the Chief Inspector of Electrical and Mechanical Equipment of the War Office.

The advantages of the welded dock gate are many, and this fact, duly recognised by many dock and harbour authorities, had resulted in an all-welded dock gate in which the simple design gains economy at all stages of the work, both from the installation and maintenance points of view. The firm of Head Wrightson & Co., Ltd. supplied three pairs of welded dock gates to Calais, and Fig. 2 shows the initial assembly, in which the segments are being tack welded to the flat skin plate. It should be mentioned in passing that although this particular contract was originally placed for unit construction, it was later amended to cover complete assembly at the works and launching and towing to site.

In the case of all-welded dock gates it is not necessary to use angle bars for attaching the skin plates, thereby reducing weight in comparison with riveted construction. Moreover, the omission of angle bars renders smithing unnecessary; neither is caulking required, because welded joints are watertight in themselves, an outstanding advantage of welded construction. The shaped plates for these dock gates are cut by oxygen profiling machines, and drilling is reduced to a minimum. Timbers do not require to be notched, since there are no angle bars at the heel and mitre posts. The meeting surfaces of timber and steelwork are made watertight by a dressing of red lead. The clean surface of the underside of the bottom deck similarly permits the clapping timber to be attached with greater security and to bed more snugly, without recourse to the notching and countersinking which are essential on riveted gates. Damaged gates of all-welded construction can be

The Use of Welding in Port Works—continued

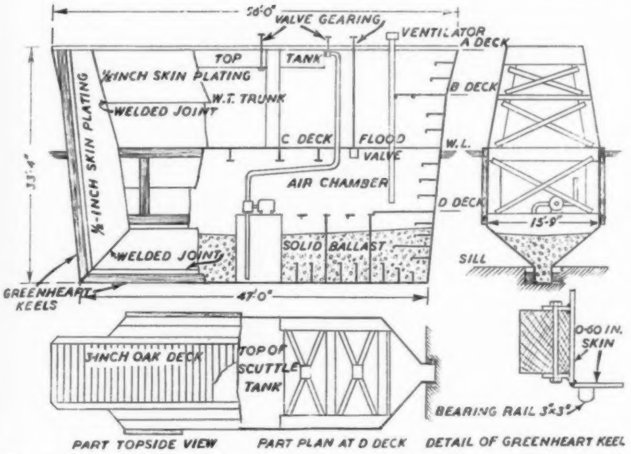


Fig. 3. All-welded floating caisson made by Vickers-Armstrong, Ltd.

very speedily and easily repaired, employing oxygen cutters to remove the damaged portions and the renewal parts being welded into position. Absence of rivet heads and other projections gives a flush surface which discourages accumulation of dirt, so that painting is thereby facilitated.

Welded dock gates and caissons have also been developed by Vickers-Armstrongs, Ltd., and Fig. 3 shows a typical welded floating caisson made by that firm. A hinged dock gate can resist water pressure in one direction only, and therefore when local conditions arise where a reverse pressure has to be held, two pairs of gates must be fitted with their rises pointing away from one another. The gates and housings then require a much extended length of entrance, and this, combined with the unsuitability of gates for carrying road or rail traffic, has led to the use of either floating or retractable sliding types of caissons. Both types, fitting into double-faced boundary slots or grooves, can effectively seal an entrance against pressure in either direction and this applies to the caisson shown in the figure referred to above.

Here again, welded construction is very suitable; this type of floating caisson being moved into or out of position completely afloat, the necessary preponderance of weight to keep it firmly in its groove is provided by admission of water ballast to the appropriate tanks in the structure. This design therefore entails consideration of stability of the caisson when freely floating, and provision for adjustment of draught when floating in or out, with specified minimum depth of water over the dock sill. When water pressures are equalised the entrance is opened by ejecting ballast from the caisson until it is afloat, and towing it clear to some convenient position for mooring. It should be pointed out that saving in weight is not a primary objective of welded construction, the most marked advantage being gained rather from transfer of the saving in connecting angles and the like into additional thickness of skin plating and ribs, thereby providng, at no extra cost, a greater margin against corrosion. This important factor, added to the elimination of hidden faying surfaces where unsuspected

Fig. 4. Unit for all-welded dock gate in trunnion manipulator.

corrosion might take place, will add very substantially to the life of a structure.

Both large and small all-welded caissons built by Vickers-Armstrongs, Ltd., at Barrow-in-Furness, have replaced those destroyed during the last war at Le Havre. Other outstanding examples are provided by the two mammoth caissons built in Australia to close the world's largest dock entrance, the 150-ft. span of the Captain Cook Graving Dock, Sydney, all-welded structures for which the above firm supplied the calculations and drawings. Another interesting all-welded structure for which this firm was responsible was a four-cylinder lifting pontoon designed to handle a road and rail bridge of 60-ft. span and also of all-welded construction. For opening the dock passage, the pontoon is submerged by ballasting with water, brought under the bridge, and the ballast is then ejected by compressed air, thus lifting the bridge clear of its abutments. Here again welded construction shows up to advantage, providing a structure which is of light weight and yet has high strength.

Inner and outer pairs of dock gates have been made at the Chepstow Works of the Fairfield Shipbuilding and Engineering Company Ltd., for the Fish Docks, Swansea, to the order of the Docks and Inland Waterways Executive. The dock gates were constructed with the aid of the simple trunnion type manipulator shown in Fig.

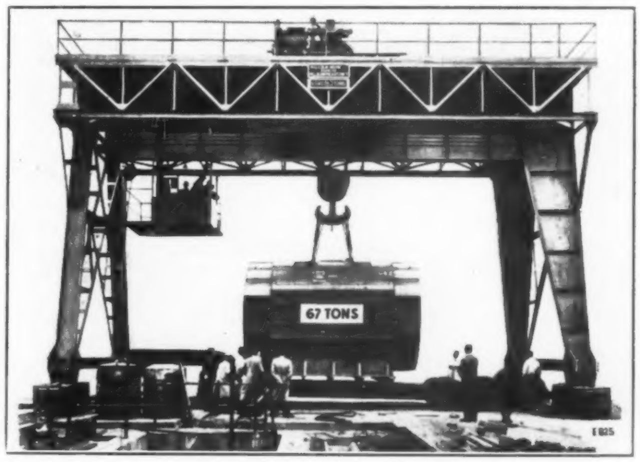


Fig. 5. Welded 80-ton gantry crane for Australia.

4; this manipulator comprises a pair of heavy I-beams mounted on cranked trunnion supports, used in conjunction with the overhead electric travelling crane in the shop, for turning the assembly. The gate has a curved face on the outer side and a flat face on the inner side. From the bottom of the gate to the top the total height is 28-ft. 4-in., with nine watertight decks in the horizontal plane and five vertical bulkheads, so that we have a cellular type of structure for which welding provides an excellent solution.

Considering some typical welded joints, the butt weld on the flat side of the gate between the ⅝-in. and the ½-in. plates has a 60° vee preparation, the first run having been laid down with an 8-gauge electrode and the welding current being 170 amps., quantity of weld metal used having been 22½-in. per foot run of weld. The gap between the flat roots on each plate varied from a minimum of ⅛-in. to a maximum of 3/16-in. The second run was laid down with a 4-gauge electrode, using 26½ inches of electrode per foot of weld, the welding current having been 260 amps.; the sealing run, on the opposite side of the plate was laid down with an 8-gauge electrode, using 12 inches of electrode per foot of weld and a welding current of 170 amps.

The joint between the bottom plate of the gate and the flat skin is also of interest. Here the tolerance on the bevel preparation is from a minimum of 1/16-in. to a maximum of 3/32-in. In Fig 6 we see the heel and core plate assembly, from which it will be noted that the core plate is held in position for the welding by a number of sloping struts on each side which control distortion and which are knocked away after the ⅝-in. fillet weld has been laid down on each side. The plate just visible near the ends of the

The Use of Welding in Port Works—continued

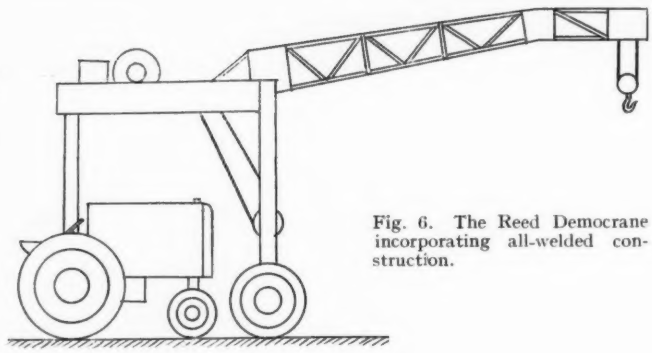


Fig. 6. The Reed Democrane incorporating all-welded construction.

two skin plates is a reinforcing web between watertight decks, and is held in place with a 7/16-in. fillet on each side; a 2-in. radius is removed at the corners so that the main welds can be laid down without interruption.

An interesting point of detail with welded dock gates is the provision of circular and oval internal access holes because these show the advantage of welded construction. A similar arrangement with a riveted structure would entail smithing of the reinforcing angles whereas in the case of welded fabrication each ring is formed in plate rolls from flat plate, the open end is butt welded and the ring is attached to the plate on each side by fillet welds after having been tacked. The radii at the corners of plates and at the ends of stiffeners are also noteworthy.

All-welded construction is particularly useful for cranes, and Fig. 5 shows an 80-ton gantry crane which was built for the State Electricity Commission of Victoria by Malcolm Moore Proprietary, Ltd., Melbourne, and erected at the Brunswick Terminal Station. It is employed for the installation and servicing of large rotary condensers in the machine building, and is the type of crane which will be of considerable interest to dock and harbour engineers who are often faced with heavy lifting problems.

Height of this crane from rail level to the top of the crab is 37-ft. and the span is 45-ft., the crab being provided with a two-speed hoist motion and being capable of lifting the 80-ton load at a speed of 2.8-ft. per minute, or a load of 10 tons at 19-ft. per minute. The structure is electrically welded and the main connections are bolted, a very convenient form of structure where erection on site is concerned. The bridge is of plate girder construction with lattice bracing and the bottom chords of the outer auxiliary girders form runways for auxiliary hoists with a lifting capacity of 2½ tons. One of the portals supporting the bridge is rigid and the other is free, whereby a statically determinate structure is achieved. Each portal has two independently hinged two-wheel bogies, one driving and the other trailing.

Any development in rapid mechanical handling gear is of interest to dock and harbour engineers, who may be able to gain useful ideas from those practised by other industries. For example, the Reed Democrane shown in outline in Fig. 6 was designed for agricultural work, to handle large quantities of potatoes in harvest time. In this equipment, made by the firm of C. E. Reed and Co., Ltd., of Bristol, the hoisting unit is self-contained, but propulsion and manœuvring are provided by the user's own vehicle, a tractor or lorry, which is therefore free to carry on its normal duties when not required for crane work. This is a condition often found in dock cargo handling work, to which the design might profitably be adapted with the necessary modifications.

The Democrane was developed by the above firm in collaboration with the National Institute of Agricultural Engineering, which has done so much to encourage the use of new mechanical handling equipment in the industry. The specification was very stringent: delivery had to be within six months; the unit had to be completely detachable without compromising the tractor's ability to carry out normal duties; it had to be completely manœuvrable, including ability to slew; finally, it had to be strong, simple and reliable, able to withstand prolonged hard work without appreciable deterioration. All these requirements find an echo in modern mechanical handling appliances for docks and wharves.

Great care was taken with the design, and the specification was carried through to a tested working prototype in six months, an all-welded design being selected at an early stage. It had the advantages of speed in construction with high strength and rigidity, enabling minor problems connected with control gear and rope arrangements to be solved on site, using the prototype machine as a model. Drilling of holes and use of bolts and rivets for fixings would have made such flexibility in construction almost impossible.

Construction of the chassis involved two positions of welding, downhand and vertical. The former was carried out with Murex Fastex 5/6 gauge electrodes, chosen because it is extremely flexible and because both light and heavy fillet welds had to be deposited with the same gauge. Vertical position welding was carried out with 8-gauge Murex Vodex electrodes, obtaining joint efficiencies comparable with the downhand welds. The chassis was rotated once only to complete welding of the cross-members.

Final welding was carried out at the top of the axle pillars. Advantage was taken of the fact of inversion, the axle assembly being held upside down for welding operations which completed the chassis. Welding of the jib was mainly in the downhand position, using Fastex 5 electrodes. The width of the jib is 2-ft. and its depth is the same as its greatest dimension, which made it an easy subject to roll and thus avoid position welding. The use of Vodex electrodes in overhead welding was claimed to give easy operation in awkward places. The latter were numerous and included sheave-wheel rope guards, catwalk brackets, jib travel stop shaft, brake linkage brackets and so forth, which were attached by trial, making full use of light tacking.

All chains and gears were enclosed by 20-gauge sheet metal guards reinforced by grooving, care being taken to ensure perfect fit at the edges. This precaution enabled the welds to be run down with the oxy-acetylene blowpipe without the use of a filler rod, thereby minimising distortion by reducing heat input. Delivery of the equipment was made to time and the overload testing amounted almost to abuse, yet the equipment stood up to the test without developing any trouble. The tractor was a Fordson Major, and the whole project demonstrates very clearly the outstanding advantages of welded construction. It is for that reason that the author has dealt with this interesting development at some length, hoping that it may stimulate thought in the evolution of a similar equipment for dock handling services, especially at smaller ports or privately owned wharves.

Welded fabrication is also a particularly suitable form of construction for warehouses and similar buildings, a striking example of this being provided by a building in Durban, the main features of the design being shown in Fig. 7. This building is believed to be the first all-welded frame structure in Durban, the second largest port in South Africa, which, during the last few years, has been rapidly developing as an industrial centre. The structural framework for this building was designed by M. S. Zakrazewski, A.M.I.C.E. in collaboration with N. C. Fletcher, consulting engineer; the building itself was designed by D. C. Calvert McDonald, a Durban architect

The use of portal frames allowed reduction of the total height of the building by at least 2-ft. 6-in., thereby providing much unobstructed headroom in the central portion of the bay. Neat

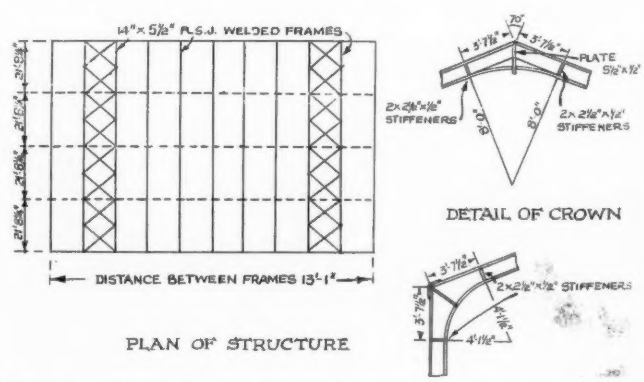


Fig. 7. Main features of a welded frame building at Durban.

The Use of Welding in Port Works—*continued*

appearance and ease of maintenance were added advantages of the welded construction and these qualities are likely to appeal to dock and harbour authorities. The structural skeleton is a mixed steel and reinforced concrete construction of which there are many examples in Durban. The welded frame proved to be a very successful structure for covering a large span without intermediate supports, gives a clean finish and attractive appearance.

In comparing this welded structure with an equivalent riveted structure of conventional type, the economy is shown to be only about 2.7 per cent., but this was mainly due to the fact that local firms had not at that time become accustomed to welded construction of this type, and also due to the fact that heavy structural sections were used with elaborate splices. However, even with these handicaps, the result of the comparison is in favour of the welded steel frames. For the design of the portal frames use was made of scale model tests with the help of Professor J. R. Daymond, Head of the Department of Civil Engineering of the University of Natal.

Coast erosion is a matter of considerable importance to many dock and harbour engineers and it is a special problem for the Borough of Lowestoft and a source of heavy expense for the Local Authority. A third sea wall had to be constructed within living memory, the first wall having completely disappeared into the sea. The second wall is well illustrated by Fig. 8, which shows the broken remains between high and low water in front of the recent works on the third wall.

When the third sea wall was begun, timber was almost unobtainable, and in view of the huge quantities of steel which would be required, the practical advantages of welded construction were evident, both on the site and in the workshops. As a result of this, two Murex welding machines were purchased by the local authority, one a mobile set powered by a 12-horsepower Morris engine for use on the site, and the other a static set, for use in the workshops. Two workmen with experience in welding were selected and sent for an electric welding course at the Murex Training School, Waltham Cross. The design of the new sea wall included a row of Larssen section 10A steel sheet piling facing the sea and a row of Appleby-Frodingham section II steel sheet piling 20-ft. behind the Larssen. This double row of piling runs for the whole length of the job parallel to the sea for a distance of about 4,900-ft., the space between being filled with mass concrete to a depth of 6-ft., thus forming the foundation on which the reinforced concrete sea wall stands.

Before any concrete was placed, the two rows of piling were tied together with steel tie rods of 1¼-in. diameter at intervals of 3-ft. As the number of these, complete with fixings, represented a considerable item and materials of this kind were scarce, considerable thought was devoted to an economical design. It was eventually decided to use angle-iron legs from Morrison table shelters, a practical and ingenious idea, cut into sections with the aid of oxy-acetylene cutters. These angles were drilled to take the 1¼-in. diameter tie rods, which were welded to the internal faces of the piling, and the ends of the tie rods were hooked into the drilled holes. When in position, it was found that this type of fixing was the most successful, and it is shown in Fig. 9.

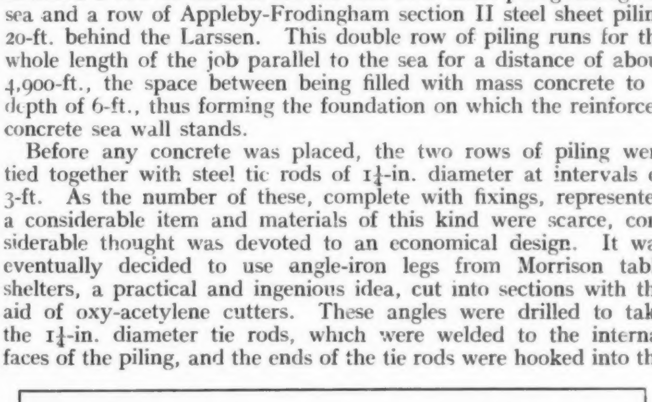


Fig. 8. Collapsed second sea wall and erection of new sea wall in progress.

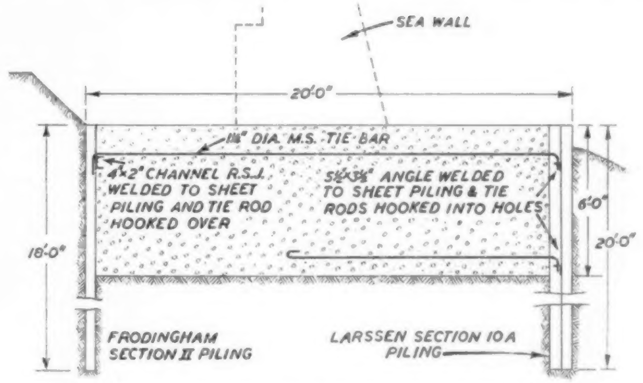


Fig. 9. Cross-section of sea wall foundation, showing arrangement of tie-bars.

For fixing the brackets to the row of Larssen piling facing the sea a vertical and overhead position in welding was necessary, and for this purpose Vodex 10 and 8 gauge electrodes were used. This welding of the brackets to the piles was frequently subjected to a severe test by the grabs of the excavators working in the cutting, which bent the brackets up or down, but it was found that they could be straightened to their original angle by sledge hammers without inflicting any visible damage upon the weld. On the rear row of sheet piling it was decided to weld Anderson shelter 4-in. by 2-in. channels in a continuous run, and the tie rods were then cranked over the channel so that the cranked end dropped into the space between the channel and the trough of the pile. For this welding use was made of Fastex 8-gauge and Vodex 10 and 8-gauge electrodes by the portable machine welder. In Fig. 9 it should be noted that 9-in. by 3-in. channels originally incorporated in the design were later replaced by the 4-in. by 2-in. Anderson shelter channels for reasons of economy.

Pile driving was carried out by McKiernan-Terry No. 6 double acting hammers, each hammer being operated by steam supplied from a Spencer-Hopwood vertical water tube boiler. Various driving conditions were encountered, and in many instances hard driving and obstructions caused some of the piles to creep out of the plumb. When this happened, one or more taper piles were fabricated and driven to ensure that the piles would be brought back to the vertical position.

Each wedge pile was fabricated in the depot workshops by cutting out an elongated taper from the rib of the pile, cramping the two remaining arms together and welding the joint thus formed. This produced a pile which diminished or increased in overall width according to whichever end was inserted when driving. Cutting was done by oxy-acetylene cutters, and it was found by experience that if the cuts were burned away at an angle, when the arms came together a vee joint was formed which was of considerable advantage to the welder. The most suitable electrode for this type of work was found to be Fastex 8 and 6 gauge; two runs with the former and one run with the latter were followed by a sealing run on the other side with the 8-gauge only. With experience, these taper piles were turned out rapidly when required.

This work is noteworthy for the many problems which were successfully overcome by trial and error and by perseverance; for example, any high tide or rough sea flooded the cutting formed between the two rows of piling. A length of the foundation was eventually completed and the shuttering for the wall itself was then required. Owing to shortage of materials, it was again decided to improvise from available materials, so that this shuttering was constructed from Anderson shelter channels of 4-in. by 2-in. section for the formers and of Morrison shelter plates ⅛-in. thick for the front and back faces. Construction of this shuttering demanded careful and accurate welding in order to avoid distortion and yet at the same time to permit easy assembling and dismantling. This was successfully achieved at the depot workshops, each section being fabricated, erected, marked, dismantled, transported to site

The Use of Welding in Port Works—continued

and finally erected there in position (see Fig. 10), for the assembly of reinforcement and for concreting.

By the time that this stage of the work had been reached, the depot workshops had been extended by stages to cover all sections of the engineering side. Shops for blacksmiths, steam fitters, electrical engineering, oxy-acetylene and electric welders, motor mechanics, pipe fitters, and other trades, had been built or converted from existing buildings. Various items of plant, such as excavators, bulldozers, hammers, motor and steam winches and other equipment used on site were all maintained from these shops.

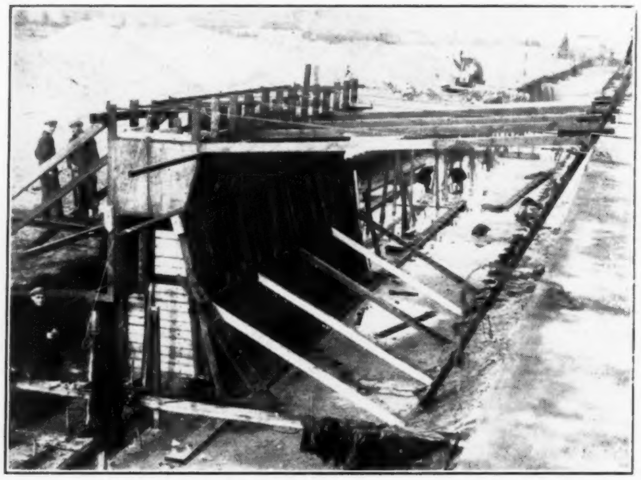


Fig. 10. Shuttering for sea wall fixed in position and ready for placing of reinforcement and concrete.

As the construction of the sea wall proceeded satisfactorily, a start was made on the 18 groynes which were required in front of the wall, and again due to shortage of timber it was resolved to improvise as much as possible on their design and construction. One of the successful improvisations was the use of 9-in. by 4-in. steel channels from the walings running horizontally along the groynes, and these were joined together by using plates welded inside one waling and outside the next to form a joint. These plates were then drilled to a uniform pattern, the walings butted together and the plates bolted up. Shortage of steel tubing compelled the use of steel piping used for beach defences, of which thousands of feet were welded together to provide water service for the boilers supplying steam to the pile hammers, and sited at intervals throughout the entire length of the job.

From the welding point of view, one of the most successful achievements was the butt welding of short piles to convert them into long ones. With the collapse of the second sea wall, the sea had gained considerably, and the depth of water close inshore was greater than when the original soundings were taken. In many cases the sheet piles purchased for the groynes were too short, and it was therefore decided to try butt welding the piles, making two long piles out of three short ones. Every third pile was first cut in two by oxy-acetylene cutters, again using the technique of the vee cut, and then each half-pile was welded to the remaining two piles by using Fastex 8 and 6 electrodes, as in the case of the taper piles already described above.

This operation was carried out while the piles were cramped to girders to ensure that the interlocking grooves matches and that no distortion took place during welding. Many of these piles were used for the groynes, and in spite of much hard driving no failure of a butt weld was reported during the course of the work.

The above is but a brief review of a few of the many applications of welding to different types of work in which dock and harbour engineers are interested, but it should be emphasised that the success of welded structures depends very largely on efficient training of welders, and on suitable testing methods, methodically and regularly applied. During the last few years there has been a remarkable growth in the use of mobile X-ray inspection equipments suitable for use in the field or in the welding shop. For example, the Philips Macro 150 X-ray inspection unit is claimed to be an ideal inspection unit. This has been designed for examining welded components up to a maximum thickness of 2-in. of steel, and with such equipment there is never any doubt about the soundness of the weld.

This apparatus comprises a high-tension transformer and a shock-proof and ray-proof tube mounted on a mobile stand, a control table of the desk completing the assembly. An outstanding feature of this unit, likely to appeal to dock and harbour engineers, is its mobility, which enables it to be used in positions formerly considered to be inaccessible to radiographic technique.

Another comparatively recent development is the gamma-ray inspection device of Gamma Rays Ltd., Smethwick, which can be used for the inspection of welded sections from ¼-in. to 11-in. in thickness. This apparatus is readily portable and gives equivalent results to that obtained with an X-ray set up to a maximum output of 2,000 k.v. This equipment has been installed in many industrial concerns in order to ensure that welded components are fabricated to the required high standards. The equipment is suitable for the various radioactive isotopes such as radium, radon, cobalt 60, tantalum 132, irdidium 192 and so forth, which can be changed with ease and speed. It is important to use the isotope best suited to the job in hand, and this firm is able to make the necessary arrangements with the Atomic Energy Research Establishment to collect and seal the isotope in a special container for delivery to the site. This system is of considerable economic importance to any concern undertaking welded work, the cost of radioactive energy working out at about £20 per year.

New Warehouses for Stockholm

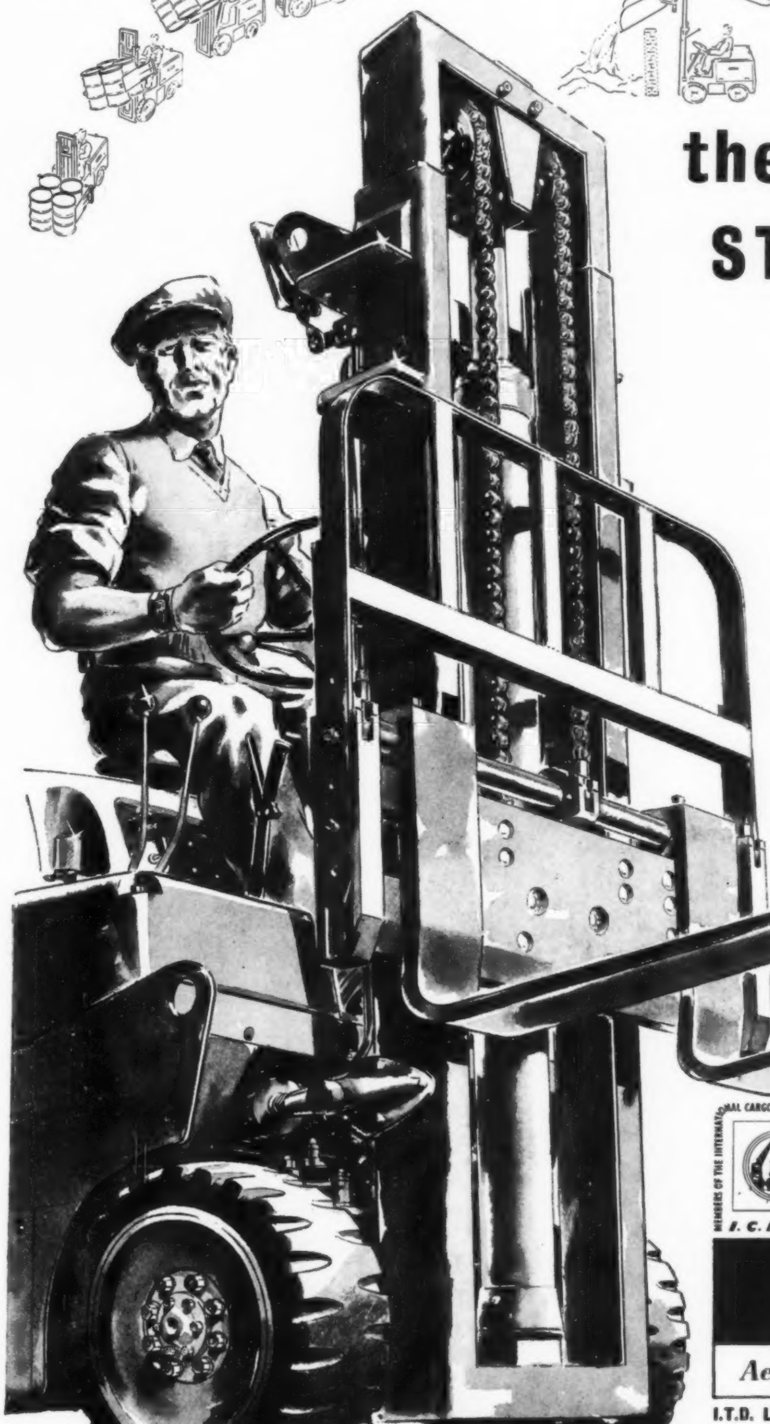
New type warehouses, belonging to the City of Stockholm, have recently been erected at the harbour there. One-storey high they have been built of horizontal Siporex slabs, which have recently attracted a good deal of interest and attention in Sweden.

These lightweight concrete elements are now made in five factories in various parts of Sweden, while plants are being set up in a number of other countries. Combining the properties of stone or brick and wood and being comparatively cheap this material also makes possible the speedier erection of buildings. It can be sawn, hewn, nailed and bored, in some respects more easily than wood. It is lighter than wood and floats better, yet it is as waterproof as stone. Not only is the material non-inflammable, but it

One of the New Warehouses at the Port of Stockholm.

is also fire-resistant. It has also good insulating properties against heat or cold. Having the same linear expansion as steel Siporex can be reinforced.

Made up from a mixture of cement, siliceous sand, water, aluminium powder and some other chemicals and substances, this lightweight concrete is put through a process of hardening by steam under pressure. This causes the sand and cement to amalgamate into a chemical compound of calcium monosilicate and gives it outstanding structural strength and bearing capacity that would otherwise be unattainable in so porous a material.



Cold Metal Repair of Port Installations

New Steel Stitching Process

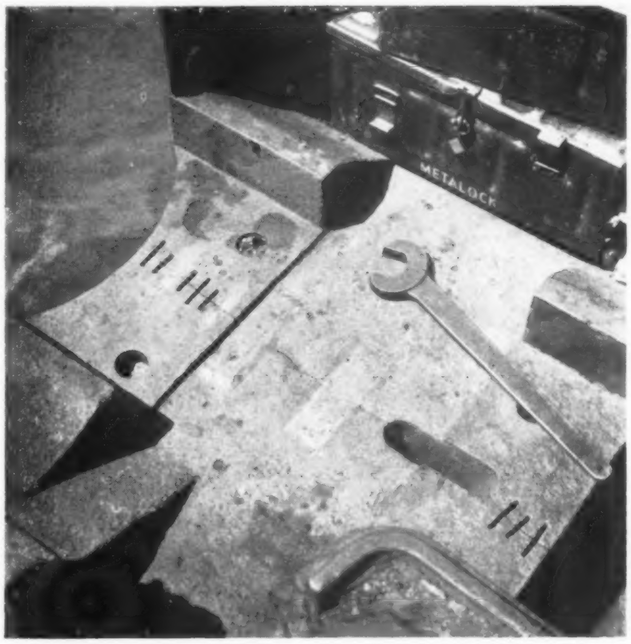
A system of effecting the repair of cracks in machinery and other castings without the application of heat, which is becoming increasing popular among dock and harbour undertakings, is known as the Metalock process. The story of the success of the technique adopted, goes back to 1935 when Laurence B. Scott developed it for repairing cracks in machinery in the oilfields of Texas. An open flame would have been dangerous in such an area and so the cold stitching process proved ideal. Before he patented the idea, Scott worked under a tarpaulin to keep the secret, but eventually a company was formed which, although in comparative infancy, performed outstanding service during the recent war. Now branches and subsidiaries are established in many parts of the world, and this unique repair process is applied to all types of commercial and dock engineering repairs.

Since January, 1948, shortly after the process was introduced to this country, Metalock (Britain), Ltd., have completed many satisfactory repairs on Dock and Harbour installations and equipment. The Port of London Authority have been constant users of this method of cold repair and the following are some typical examples of the type of job carried out:

(1) Repair of cracks, 4-ft. and 9-ft. 6-in. respectively in the hydraulic hoisting cylinders of two cranes;
(2) Repair of a cast iron operating quadrant of South Dock Cutting Bridge, Surrey Commercial Docks;
(3) Two cast iron top bearing keeps from the South Dock Communication Bridge;
(4) Repairs to two bearing blocks from the Dredger "India," carried out at Russia Dock workshops, Surrey Commercial Docks. This job was to restore a fracture of 39-in. on countershaft forward bedplate, and 33½-in. of fracture on countershaft after bedplate;
(5) Repair of approximately 4-ft. 5-in. of fracture of the Heel Anchorage block on the Inner Upper Lock Gate at Brunswick Yard, Surrey Commercial Dock. This particular job caused considerable interest at the time, and the accompanying illustrations show the work in progress. The work was completed in seven days.

Shipping is also being served daily by the Metalock process which enables work to be completed while the ship is actually loading and unloading cargo, thus saving valuable time. An interesting example was the recent repair, at a South African port, of a 14-in. crack in the upper crank case entablature of a Sulzer Diesel engine of the motor ship "Ruys." This 14,285 ton motor vessel was in Far Eastern waters when the defect appeared in the way of the inspection door between Nos. 5 and 6 cylinders. Some years ago it is highly probable that it might have been necessary to effect complete removal and replacement of a section of the entablature—weighing about five tons. This would have caused considerable delay and expense, whereas a permanent repair was completed in little over seven hours actual work.

Repair to dock gate at the Port of London.



View of holes drilled ready for inserting keys.

To effect a repair, the fractured component is, if necessary, clamped to regain alignment. By means of a jig, lines of blind holes are drilled transversely to the fracture. These pilot holes are then opened out to size, the depth of the holes depending upon the thickness of the parent metal, and the channel of metal in between the holes is removed by means of a special hand-operated pneumatic guntool. The result is then a series of holes connected by parallel sections. Into the aperature thus formed, Metalock keys are driven one after the other in layers, and peened into the parent metal. The alloys from which the keys are produced have a known tensile strength, and the correct number of keys to be used to restore the original strength is a matter of close calculation.

The fracture between the locks is then drilled and tapped to receive Metalace studs in addition to the Metalock keys. In the case of pressure vessels it is particularly important that these lacings should interlock very firmly one into the other. After the lacings are inserted, the whole repair is pneumatically cold worked to ensure perfect tightness and rigidity and the full surface of the repair is then ground flush.

A further application of this process is the Masterlock, which serves as a shock absorber, as well as replacing strength into sections of great and concentrated stress. The Masterlock is a block of special high tensile alloy around the perimeter of which runs a series of half-round holes. The Masterlock is sunk into the cast-iron, both surfaces being flush. The half-round holes in the Masterlock match up with opposite numbers already machined in the parent metal. The resultant full holes are then filled with short alloy dowels which are again driven home and cold worked pneumatically. In most cases Metalock repairs are guaranteed, and they can and do undoubtedly save time, money and replacement.

Considerable advantages are claimed for this method of repair which enables jobs to be carried out on site and so saves dismantling. Being heatless, distortion and consequent re-machining are usually eliminated. It provides relief of inherent stress and eliminates stress concentration by re-distribution of stress, and absorbs shock through the dampening effect.

The Port of Boston, U.S.A.

Design Studies for East Boston Pier I.

By J. D. M. LUTTMAN-JOHNSON, M.A.S.C.E., M.Inst.T.*

THE historical development of the Port of Boston and an account of the various new terminal facilities being provided under the current development programme of the Port of Boston Authority have recently been described in The Dock and Harbour Authority. It may, therefore, be of some interest to look behind the scenes or, perhaps more appropriately, below the deck and try to answer the question of why a particular design was adopted for a particular terminal location. Accordingly, the case of the new terminal known as East Boston—Pier I will be cited.

Basic Criteria

Essentially, it was proposed to demolish two existing and badly deteriorated finger piers of timber construction and replace them with a modern and larger pier. This sub-structure was to measure 605-ft. long by 390-ft. wide, and support a transit-shed superstructure measuring 585-ft. long by 340-ft. wide by 36-ft. to 40-ft. high.

Basic design criteria called for a three-berth pier having aprons 25-ft. wide along the two sides and 20-ft. wide along the outboard end. A single railroad track was to serve each side apron and double depressed tracks were to extend down the centre of the pier shed.

Other criteria included a deck live load of 600 pounds per square foot or a standard 20-ton highway truck (lorry), a clear height of 20-ft. to underside of roof trusses, the absence of columns within the working area of the pier shed and a dredged depth of 35-ft. below Mean Low Water alongside the three ships' berths.

Hydrography

Location of the pier was determined chiefly by road and rail connections in the vicinity, and by the existence of adjacent piers and upland buildings and warehouses. A tidal range of 9.5-ft. between Mean Low Water and Mean High Water was used to fix the cope elevation of the aprons at approximately plus 16-ft. above Mean Low Water while making allowance for the depressed railroad track in the centre of the pier.

Hydrographic surveys of the area were made and plotted. It was found that the new pier layout had its long sides generally in the areas of highest existing ground level while the centre of the pier structure was located generally in the area of greatest existing depth. Thus, dredging to the extent of about 150,000 cubic yards was necessary to provide the minimum depth of 35-ft. alongside.

Geology

Subsurface and foundation conditions in the area of the proposed pier were explored by means of borings and laboratory tests of soil samples. Ninety per cent. of the borings were of the small casing, dry sample type, the balance being of the larger casing, core boring type. The former were driven to refusal at an obstruction of rock or boulder while the latter were driven through boulders and hardpan into bedrock a sufficient distance to establish the fact that bedrock had been reached.

In general, it was found that a deep layer of soft blue clay covered the entire area. Beneath this "Boston blue clay" as it is called, was found a layer of hard sand, gravel and clay overlaying bedrock. It was also discovered that the rock and hardpan layers were at a higher elevation at the outboard end of the pier and sloped downward towards the landward end of the pier with the high and low points occurring in diagonally opposite corners. The lower surface of the soft blue clay where it met the upper surface of the hardpan varied from about Elevation −65-ft. at the outboard end to about Elevation −110-ft. at the inboard end of the proposed pier. Penetration into the hardpan by the small casing borings varied from 0 to 24-ft. while the core borings showed the hardpan to be about 20-ft. thick.

The results of the borings and laboratory tests on the soil samples were carefully studied and used in developing alternate pier substructure schemes. They were also used in determining the amounts of settlement to be expected and the required lengths of piles of different types.

Pier Substructure

For the purpose of comparing costs and other characteristics, six alternate schemes for the substructure were developed. These are shown in the accompanying typical cross sections in which the superstructure is common to all the schemes.

Scheme 1. This scheme comprises a more or less standard pier substructure having a reinforced concrete deck supported by creosoted timber friction piles throughout the entire pier area of 236,210 square feet. The transit shed superstructure is carried independently on steel H-piles driven to refusal. Due to the extreme depth of clay to hardpan the shorter timber piles depend upon their frictional resistance to support the deck loads. Consequently, design loads were limited to 12 tons per pile. As indicated in the cross section this scheme includes a sand and gravel fill in the central area of the pier up to an elevation of 5-ft. below Mean Low Water since the cost of this fill was computed to be appreciably less than the extra cost of the longer length piles required if there were no fill.

Settlement of the piles would undoubtedly take place due to consolidation of the underlying clay strata and would continue for several years after construction. Differential settlement of the deck between various areas of the pier shed was expected to be about 5-in. and would also continue for several years. Continuous maintenance during the early years of the structure's life would be necessary while the timber piles would be subject to marine borer action. Fire hazard in a structure of this type is appreciable despite the use of a concrete deck and the provision of fire stops. But timber piles and caps cannot be protected from oil fires.

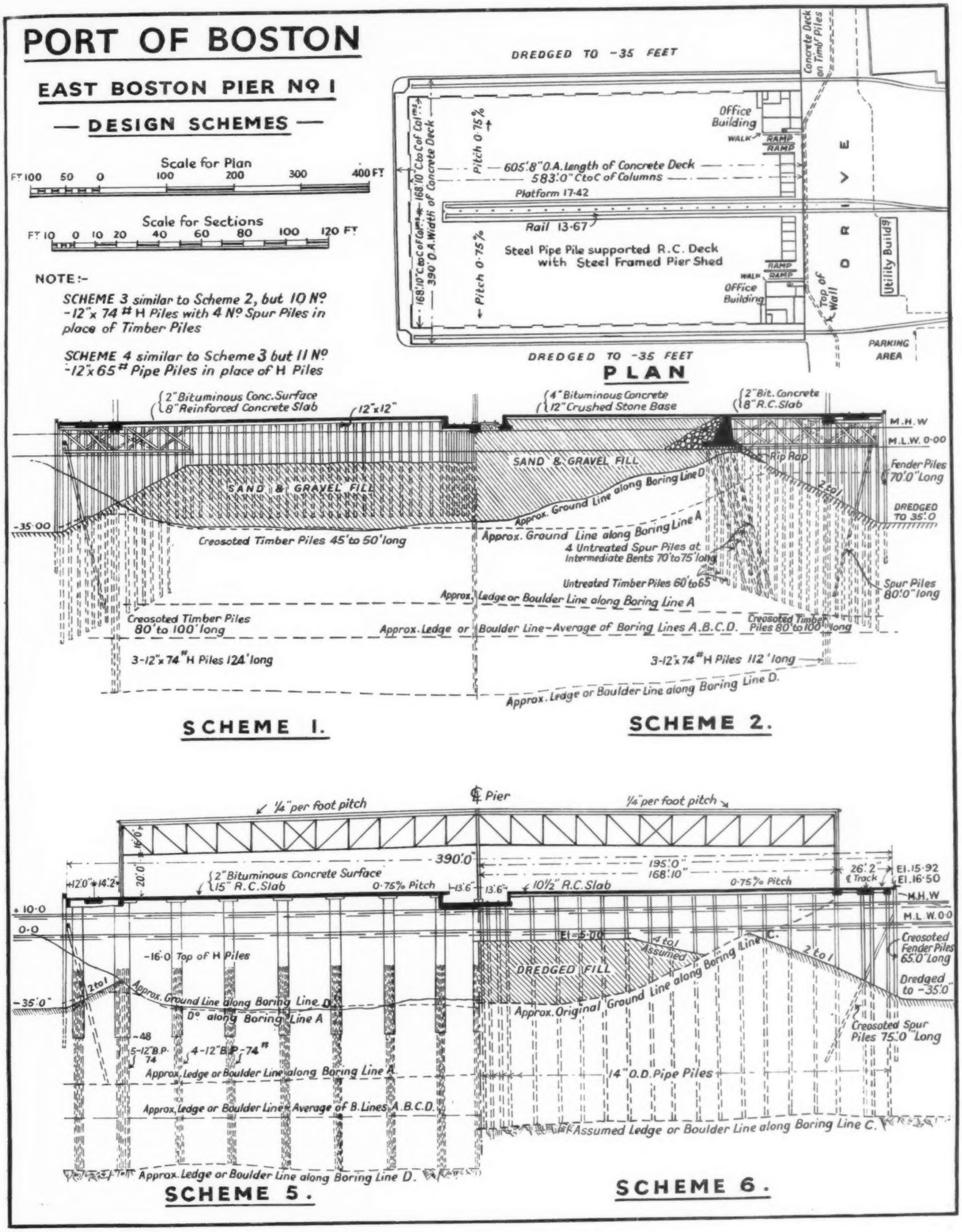
Scheme 2. This scheme comprises a bituminous concrete paving laid upon sand and gravel fill in the interior area of the pier, and a reinforced concrete deck supported on creosoted timber piles in a 74-ft. wide perimeter area along the two sides and at the outboard end. The interior fill is retained by a mass concrete retaining wall supported by untreated timber piles with their cutoff at about 2-ft. above Mean Low Water. Here again, the superstructure is supported independently on steel H-piles driven to refusal. The piles in the perimeter area are friction piles as in the case of Scheme 1 and have the same design load.

Settlement which would take place due to the consolidation of the clay would be greater than in the case of Scheme 1 because of the much greater weight of fill placed on the clay. Settlement of the interior fill would be at a slower rate when compared to Scheme 1 since there would be no consolidation from pile driving during construction. It was estimated that in Scheme 2 the differential settlement between the various parts of the deck area might amount to as much as 20-in. Maintenance of this interior fill supported area of roughly 128,400 square feet would be necessary over a considerable period of time, while the timber piles would be subject to marine borer action. Although limited to the perimeter area, fire hazard is still present despite the provision of fire stops.

Scheme 3. This scheme is generally similar to Scheme 2 except that steel H-piles take the place of timber piles in the perimeter area. The steel piles were designed for end bearing with loads up to a maximum of 53 tons per pile. The superstructure is supported independently on steel H-piles driven to refusal.

Differential settlement of the interior filled area in Scheme 3 was

*Senior Engineer; Fay, Spofford and Thorndike, Consulting Engineers, Boston and New York.


PORT OF BOSTON
EAST BOSTON PIER No. 1
— DESIGN SCHEMES —
Scale for Plan
FT 100 50 0 100 200 300 400 FT
Scale for Sections
FT 10 0 10 20 40 60 80 100 120 FT
NOTE:-
SCHEME 3 similar to Scheme 2, but 10 No. -12"x 74# H Piles with 4 No. Spur Piles in place of Timber Piles
SCHEME 4 similar to Scheme 3 but 11 No. -12"x 65# Pipe Piles in place of H Piles
DREDGED TO -35 FEET
Concrete Deck on Timb' Piles
Office Building
WALK
RAMP
Pitch 0.75%
605'.8" O.A. Length of Concrete Deck
583'.0" C to C of Columns
Platform 17.42
Rail 13.67
168'10" C to C of Col'ms
390' O.A. Width of Concrete Deck
Steel Pipe Pile supported R.C. Deck with Steel Framed Pier Shed
Top of Wall
DRIVE
Utility Build'g
PARKING AREA
PLAN
2" Bituminous Conc. Surface
8" Reinforced Concrete Slab
12"x12"
4" Bituminous Concrete
12" Crushed Stone Base
2" Bit. Concrete
8" R.C. Slab
M.H.W
M.L.W. 0.00
SAND & GRAVEL FILL
Rip Rap
Fender Piles 70'0" Long
2 to 1
DREDGED TO 35'.0
-35.00
Approx. Ground Line along Boring Line D
Approx. Ground Line along Boring Line A
Creosoted Timber Piles 45' to 50' long
4 Untreated Spur Piles at Intermediate Bents 70' to 75' long
Untreated Timber Piles 60' to 65'
Spur Piles 80'.0" long
Approx. Ledge or Boulder Line along Boring Line A
Creosoted Timber Piles 80' to 100' long
Approx. Ledge or Boulder Line - Average of Boring Lines A.B.C.D.
Creosoted Timber Piles 80' to 100' long
3-12"x 74# H Piles 124' long
3-12"x 74# H Piles 112' long
Approx. Ledge or Boulder Line along Boring Line D.
SCHEME 1.
SCHEME 2.
℄ Pier
1/4" per foot pitch
390'.0"
195'.0"
168'.10"
26'.2"
℄ Track
El. 15.92
El. 16.50
12'.0"
14'.2"
20'.0"
16'.0"
2" Bituminous Concrete Surface
15" R.C. Slab
0.75% Pitch
13'.6"
10½" R.C. Slab
+10.0
0.0
M.H.W
M.L.W. 0.0
El. -5.00
4 to 1 Assumed
Approx. Original Ground Line along Boring Line C.
2 to 1
Creosoted Fender Piles 65'.0" Long
Dredged to -35.0"
-16.0 Top of H Piles
DREDGED FILL
-35'.0"
Approx. Ground Line along Boring Line D
D° along Boring Line A
-48
5-12" B.P. 74
4-12" B.P.-74#
Creosoted Spur Piles 75'.0" Long
Approx. Ledge or Boulder Line along Boring Line A
14" O.D. Pipe Piles
Approx. Ledge or Boulder Line - Average of B. Lines A.B.C.D.
Assumed Ledge or Boulder Line along Boring Line C.
Approx. Ledge or Boulder Line along Boring Line D.
SCHEME 5.
SCHEME 6.

Port of Boston, U.S.A.—*continued*

Artist's impression of the new East Pier No. 1.

expected to be about the same as in Scheme 2. However, the differential settlement between the perimeter area, where settlement would be negligible, and the fill would be greater than in the case of Scheme 2. Maintenance would be about the same as in Scheme 2, since the timber piles are subject to marine borer action on the one hand and the steel piles are subject to corrosion on the other.

Scheme 4. This scheme is similar to Scheme 3 except that the steel H-piles in the perimeter area are replaced with steel pipe piles similarly spaced. These pipe piles are of the closed end type, filled with concrete, driven to refusal and having a design load up to 53 tons per pile.

Settlement probabilities would be similar to those of Scheme 3. Maintenance of the fill supported deck would be about the same as in Scheme 3 but less in the perimeter area since the steel pipe piles offer less surface area for corrosion than do the steel H-piles.

Scheme 5. This scheme comprises a reinforced concrete deck carried by steel caissons spaced generally 25-ft. on centre each way. The deck is of flat slab design and the steel caissons, filled with concrete, contain steel H-piles driven to refusal with a maximum load of 75 tons per pile.

Settlement of this structure would be negligible and maintenance would be at a minimum. Fire hazard would be almost non-existent since all materials are fire resistant.

Scheme 6. This scheme consists of a reinforced concrete deck supported by steel pipe piles covering the entire pier area. It is therefore similar to Scheme 1 except that the central sand and gravel fill is replaced by easily deposited dredged fill and steel pipe piles replace the creosoted timber piles, but are driven to the boulder line. The pipe piles are similar to those described in Scheme 4.

Settlement of this structure would be negligible and maintenance costs would be close to a minimum. Fire hazard is almost non-existent due to fire resistant materials.

Construction Costs.

Based upon the unit cost of a typical transverse strip of the pier measuring 25-ft. wide, the estimated construction costs in January, 1950 of the substructure only for each of the six schemes described above and excluding certain features common to all schemes are shown in tabular form. In each case the cost of required dredging is included.

Estimated Cost of Substructures

Scheme	Description	Estimated Substructure Cost
1	Timber Pile with Submerged Fill ...	$2,705,000
2	Timber Pile Apron with Solid Fill ...	$2,475,000
3	Steel H-Pile Apron with Solid Fill ...	$2,657,000
4	Pipe Pile Apron with Solid Fill	$2,662,000
5	Steel and Concrete Caissons	$3,753,400
6	Pipe Piles with Submerged Dredged Fill	$2,803,800

It will be observed that Scheme 2 is the least expensive and that the estimated costs of the other schemes except Scheme 5 all lie within 15 per cent. of Scheme 2.

Selection of Final Scheme.

A comparison of the six schemes in their order of preference for various reasons is shown in tabular form. The notation "design factor" includes simplicity and certainty of design assumptions and other favourable factors which enter into the design and construction of this type of waterfront structure.

Scheme Preference Comparison

	Scheme 1 Timber Piles	Scheme 2 Timber Piles and Solid Fill	Scheme 3 Steel H-Piles and Solid Fill	Scheme 4 Steel Pipe Piles and Solid Fill	Scheme 5 Concrete Filled Steel Caissons	Scheme 6 Pipe Piles
Length of Life	5	5	4	2	1	2
Differential Settlement	3	4	6	5	1	2
Maintenance Cost	6	5	4	3	1	2
Fire Resistance	6	5	4	2	1	3
Design Factor	3	4	4	4	1	2
Construction Cost	4	1	2	3	6	5

Both Schemes 5 and 6 possess an additional advantage in that the water depth in the berths alongside may be increased to 40-ft. below Mean Low Water at any time in the future without affecting the structure.

(Concluded at foot of next page)

Cargo Handling and Mechanisation

Correspondence from the Antipodes

To the Editor of *The Dock and Harbour Authority.*

Dear Sir.

Cargo Handling at Ports

In supporting the contentions of Dr.-Ing. H. Neumann on the merits of wharf cranes in the efficient handling of cargo, which appeared in the " Dock & Harbour Authority " for June, 1952 (and in respect of which I wrote to Dr. Neumann expressing my approbation of his article), I believe it appropriate to mention the experience of the Port of Melbourne based on many years of port operation where berths with and without wharf (quayside) cranes are available to the shipowner.

Whether wharf cranes or ship's gear are used in this port is entirely at the shipowner's discretion. The shipowner can apply for a berth with or without cranes, with or without rail facilities, and with a narrow or wide wharf apron, and, with various sizes and types of transit sheds or open berths with wide or narrow platforms. Within normal operational limits he is free to make application for a berth to blend vessel, cargo and berth characteristics to the best advantage. In such matters it must be accepted that the shipowner or his agent is a knowledgeable person in terms of the economics concerning the vessel's visit to the port. Our experience in Melbourne has been that, despite the installation of faster and more efficient gear on ships, the demand for crane berths is continuously heavy. The yearly usage of all cranes in this port, taken over the past ten years, has averaged 2,600 hours per crane per annum.

It is significant that during the war years when this port was, from early 1942, an important south-west Pacific base for Allied shipping, American shipmasters and their agents were insistent that their vessels should be allocated to berths where they could be served by shore cranage. The demand might scarcely have been anticipated, since most U.S.A. ports rely on ship's gear, sometimes aided by shore based cargo masts. Some cranes serving rail berths and handling general cargo average 4,000 hours a year during this period.

In the early introduction of wharf cranes to this port, the Commissioners found that the service which they were giving did not make cranes an economical proposition. However, experience convinced the shipowner of their value and for many years past a close equation has been kept between cost, operating and maintenance expenses, and revenue return from cranes. It is a matter of interest that 3-ton level luffing wharf cranes are hired to stevedoring companies at only 24s. 4d. per hour, including driver's wages. This is the same as the standard rate levied for a mobile crane or fork-lift truck, with driver, but nevertheless we remain financially on the credit side.

In the Port of Melbourne mechanisation plans follow a policy of providing crane and non-crane berths. Both ship's gear and cranes have their place in port operations and it is the responsibility of the port authority to ensure that a proper balance is maintained in the facilities which they provide. Well informed demand and the initiative of the port authority in feeling the pulse of the port's trade are the fundamental factors underlying all new crane installations.

Wharf cranes have a great number of advantages, not the least of which is their ability to plumb the square of the hatch and deck cargo, as well as three or four sets of rail tracks. Melbourne is amply provided with wide wharf aprons, multiple rail tracked berths, and much trade takes place directly to or from rail trucks. Cranes are invaluable for such work, making for quicker working and eliminating delays through shunting.

We find that cranes are admirably suited for working in conjunction with fork lift trucks and palletised cargoes, both in the holds of vessels and on the wharf aprons where congestion can and does occur with ship's gear, but is eliminated through the greater area commanded by wharf crane. Stevedores estimate that the use of wharf cranes often means a saving of as much as 20 per cent. in the time of a vessel's stay in port, so that cranes are the equivalent of extra berths in the port.

A new, fully mechanised steel handling berth now under construction by the Trust will free for general cargo handling three berths now employed in this class of trade and served only by ships using their own gear. Similarly two mechanised coal handling berths now under construction at the new Appleton Dock will free for other purposes six present coal berths of which only two are provided with a form of partial mechanisation.

I believe that the prejudice against wharf cranes in some Australian ports stems from lack of practical experience. Melbourne suffers from no such limitation and the mechanical equipment already available for handling cargo is being greatly supplemented. In common with all other port facilities, cranes are to-day not inexpensive in their initial cost, but our experience is that they pay rich dividends in many ways, including the faster turn-round of ships and an overall saving in the capital investment in the port's berthage system.

Melbourne Harbour
Trust Commissioners,
Australia.
21st March, 1953.

Yours faithfully,
A. D. MACKENZIE,
Chairman.

To the Editor of *The Dock and Harbour Authority.*

Dear Sir,

Mechanisation.

It is noted on page 233 of your December, 1952, " Dock and Harbour Authority " in a published letter from the Statistical Officer of the Port of Sydney that a statement is made that " there has been an uninformed demand for this type of equipment (quayside cranes) in Australian Ports and it is possible that the casual reader of Dr. Neumann's articles might conclude that the relative lack of these cranes in the Antipodes is concrete evidence that our ports fall far short of modern standards."

From this statement it might be deduced that there is a lack of quay cranes in the Port of Fremantle, which is " in the Antipodes " but is also some 2,500 miles as the crows flies, from the Port of Sydney.

The Port of Fremantle has adopted a vigorous mechanisation policy and for years has equipped its berths with quay cranes, bag-loader conveyors, and similar mechanised equipment designed to augment ships' gear for the rapid loading or discharge of ships. Use of the quay cranes is a matter usually left for the decision of the shipowner, but in general it may be stated that quay cranes are fully made use of by the shipowner and hired from the Port Authority for augmenting ships' gear.

The conditions at Fremantle in the matter of loading or discharge of ships are distinctive to the port. Imports, roughly, are equivalent in volume to exports, and bulk cargoes are, roughly, of the same amount as general cargo. Full cargoes are in the minority and constitute bulk cargoes and interstate general cargo ships only. Overseas ships, by far the greater number carrying general cargo, carry part cargoes only, usually stowed in the upper and more awkward portions of the ship's hold, the port being the first and last Western port of call in the Australian trade.

The Port is virtually tideless, the conditions being similar to those obtaining in the Mediterranean.

Port of Boston, U.S.A.—continued

The scheme finally recommended was Scheme 6. This recommendation was later accepted by the Port of Boston Authority who instructed the consulting engineers, Fay, Spofford & Thorndike, to prepare detailed contract drawings and specifications. Construction bids were called for in September, 1950, but partly on account of the Korean War no award was made at that time. Bids were again called, in July, 1952, for the dredging contract and in December, 1952, for the main contract.

Both the dredging and the main contracts have since been awarded. Work on the dredging and demolitions commenced in October, 1952, while work on the main contract is to commence in the present month. There are 2,101 pipe piles to be driven varying in estimated length between 82-ft. and 132-ft., with an average length of 106-ft. The project is scheduled for completion in February, 1955.

Correspondence—continued

Berths are modern in design, marginal and land-backed, with reasonably wide aprons and medium width transit sheds. They are served with road and rail connections to the rear of the transit sheds and to quay aprons and are capable of handling either bulk or general cargoes. There is no lighterage in the port, and all cargo working ashore is on the single deck principle. Some berths have rear raised platforms to transit sheds, the latest have level floors throughout with no platforms. Hook for hook there is little difference in the operational speed of ships' gear versus quay cranes at Fremantle.

These notes give a background to the Port of Fremantle and are of value when considering the points referred to by Dr. Neumann in his article in the "Dock and Harbour Authority" of June, 1952.

Regarded in the light of expensive items of equipment, and in the light of duplicating gear already installed as standard items on ships and which has improved each year in speed, number and efficiency, quay cranes for general cargo working at Fremantle can only be considered necessary for cargo handling ex ship if more than single hook working per hatch (by ship's gear) becomes justified.

In Fremantle conditions, where both ships' gear and quay cranes are operated at a berth simultaneously, ship turn-round time is considerably reduced—a highly desirable requisite. By careful application of more hooks to the larger holds, all holds can complete nearer together than is possible with ship's gear only—again lessening ship turn-round time and improving berth efficiency.

Although ship's gear is designed up to a point to cater for this, some holds having perhaps two or more sets of gear, the additional usage of quay cranes improves uniformity of hatch completion times. The proviso to be borne in mind, if quay cranes are employed in addition to ship's gear solely for speeding up ship loading or discharge (for single deck working only), is that the shore facilities must be capable of handling cargo at such high rates. If this proviso is not satisfied, quay cranes are not necessary unless they are required for other purposes.

Economic usage of quay cranes is exemplified by the usage of them as at Fremantle.

Fremantle berths are not hired to individual shipowners, but are operated by the Port Authority, which, in addition to owning the port installations, employs the shore labour and operates as wharfingers, receivers and deliverers of goods.

For some years now there have been more ships than berths available. There has been delay in implementing planned programmes for port expansion. The emphasis, therefore, has been on increased efficiency per berth. A contributory factor to berth efficiency has been the flexibility of use of quay cranes at the various berths, in that the cranes can be moved and concentrated readily where required. In general one or two crane hooks per ship augment ship's gear, but at times 12 or 13 hooks have been working at a 5-hatch ship, 5 or 6 quay cranes being used.

The demand for quay cranes is such that 13 more are now on order for early delivery. Their efficient and economic use at Fremantle in improving ship turn-round and increasing berth efficiency and port capacity, has been proved.

Fremantle has adopted a full mechanisation programme and is indeed to-day one of the foremost ports in the world in its use of fork lift trucks, palletisation, mobile cranes, tow motors and trailers.

Yours faithfully,

F. W. E. TYDEMAN, C.I.E.,
B.Sc.(Eng.)London, M.Inst.C.E.,
M.I.Mech.E., M.I.Struct.E.,
M.I.E.Aust., M.Inst.T.
General Manager.

Port of Fremantle.
Australia.
25th March, 1953.

To the Editor of *The Dock and Harbour Authority*.

Dear Sir,

Meteorological Surges in the North Sea

May I supplement what has been written by Commander D. H. Macmillan on the above matter in your March issue and confirm his views? The work of Dr. Doodson and Mr. Corkan is of the highest importance in this connection.

In addition attention should be drawn to the remarks of Miss Rachel Carson in her excellent book "The Sea Around Us," regarding the probability of a steady rise of the sea level. This seems to amount to about one or two millimetres per annum, which is not a negligible figure. Two factors enter into it as far as the East Coast is concerned. Firstly, there is a tilt due to the long term earth movements, and secondly the polar ice is continuing to melt and so return to the ocean the tied up water. Both appear to be residual effects of the glacial periods of the Pleistocene Age. A more exact determination of this rise is much to be desired and would quite well come within the ambit of the bureau which Commander Macmillan suggests.

Yours sincerely,

4, Grosvenor Villas,
Bath, Somerset.
21st March, 1953.

HERBERT CHATLEY,
D.Sc.(Eng.), M.I.C.E.

To the Editor of *The Dock and Harbour Authority*.

Dear Sir,

Prefabricated Pier on Orinoco River

I was interested in the above article which appeared in your February issue.

The construction of this pier might be considered as a development, in the more permanent form, of the Lobnitz Pierheads at Mulberry Harbour.

Whereas the advantages of the scheme can be appreciated where the site is isolated, and thus where labour, plant and materials are not readily available, they are not the same where these facilities are easily available.

An examination of costs for a similar form of construction in this country indicates that whereas the advantages of shop fabrication of large pieces, combined with simple methods of site erection problems would reduce the overall costs, these advantages may soon be absorbed in the high costs of transporting the units from works yard to site.

To enable some comparisons to be made with costs of similar dock installations constructed wholly on the site, it would be of particular interest if information could be made available of costs of the Orinoco River piers, say per square foot of finished deck.

Again, the maintenance costs of the exposed steel surfaces must be high in relation to those of concrete work.

25, Victoria Street,
London, S.W.1.
4th April, 1953.

Yours faithfully,
D. V. BUCK,
M.I.C.E., M.I.Strut.E., M.Cons.E.

To the Editor of *The Dock and Harbour Authority*.

Dear Sir,

Prefabricated Piers

As an occasional contributor to your columns, I was intrigued to read the article entitled "Prefabricated Pier on Orinoco River" published in your February issue.

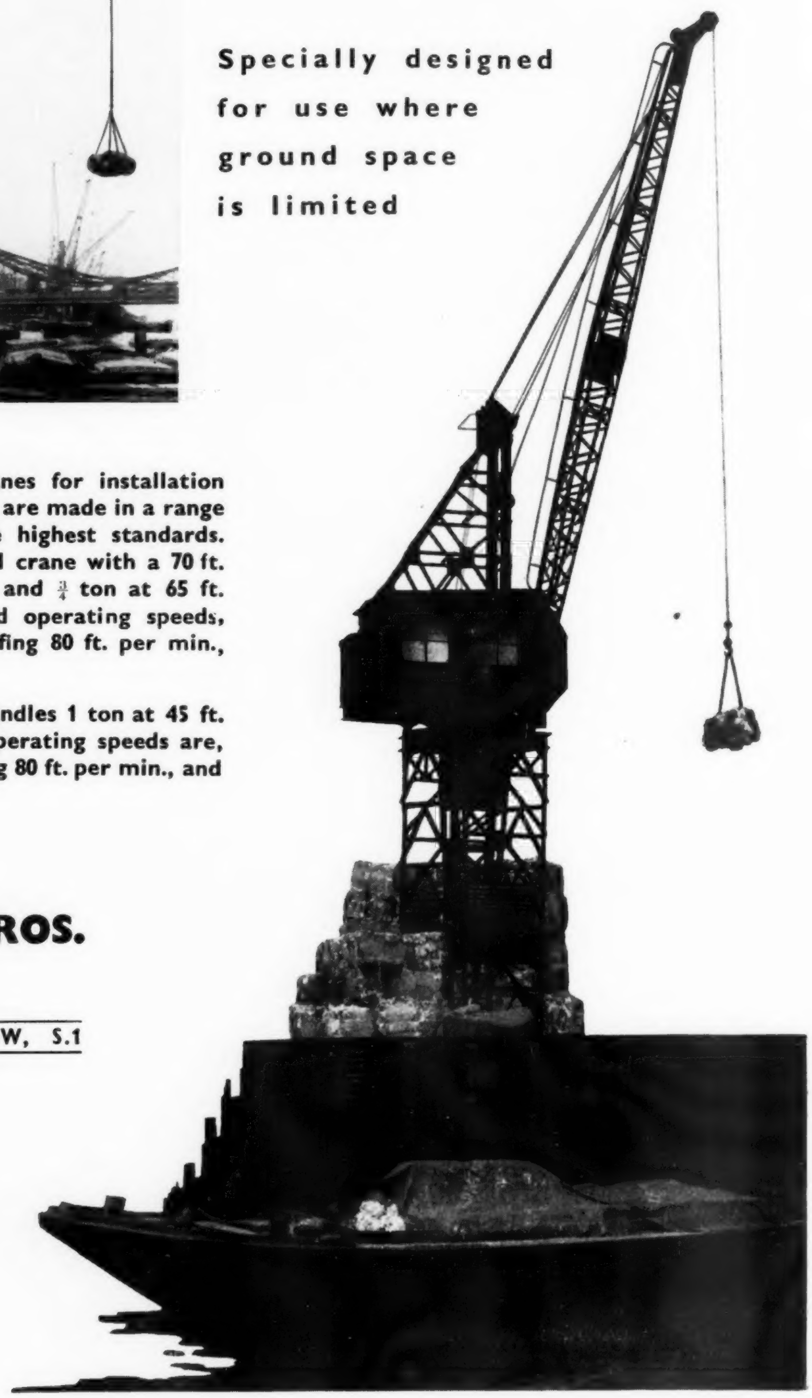
My interest was excited by seeing that someone has actually put into successful execution a method of deep water pier construction which was patented in England in the year 1920. There is, of course, no question whatever of infringement because the patent I was granted in 1920 had no application in South America and lapsed in this country many years ago. The interest is that something which originated in England more than 30 years ago should now become the subject of most successful and intelligent American exploitation, and such as can quite properly be described in your article as a "New and Unique Method of Construction."

American engineers are now in the happy position of having the plant and the material to put methods such as this into execution and deserve admiration for the enterprise they have shown in doing so. There may, however, be a crumb of comfort for British Engineers in the knowledge that in this case, as so often happens, the root idea was of British origin.

While there are some minor points of difference, a comparison of the Patent Specification and the figures accompanying it, with the illustrations in your article exhibits the close similarity.

Abbey House,
Victoria Street,
London, S.W.1.
19th March, 1953.

Yours faithfully,
G. MAUNSELL,
M.I.C.E., F.R.S.A.



Structural Timber for Dock Work

V. Joints in Timber

By P. O. REECE, A.M.I.C.E., M.I.Struct.E., A.M.I.Mun.E.

THE two most significant advances in modern timber engineering undoubtedly lie in the provision of a rational basis for the determination of working stresses and in the development of efficient shear-resisting joints. Of these two it is the latter which has been more difficult to achieve, but probably because it demanded inventiveness rather than systematic research it has attracted a multiplicity of solutions which now provide the designer with an embarrassment of riches. About two-thirds of the design section of the new Code of Practice for the Structural Use of Timber in Buildings is devoted to the design of joints, nevertheless many quite satisfactory kinds have been omitted, while the traditional carpenters' joints have hardly been mentioned.

By comparison with the riveting, bolting and welding of metals, jointing in timber may be achieved by nailing, screwing, bolting, gluing or any one of the 60-odd different types of connector patented in Europe and America since the beginning of the century. Behind all these is the age-old technique of the craftsman, now largely neglected, not because we lack the skill to employ it, but because we have sought a greater efficiency. A word on this would not perhaps be out of place, as it has been the subject of fierce argument between the protagonist of the old and the new. None would deny that the traditional joints of the craftsman in wood could be — and usually were—things of austere beauty and joys of precision. By their own standards they were efficient but it was the standards which were too low, and which could not satisfy modern needs. It was accepted that timber was weak in shear and that nothing could be done about it. This was the governing limitation within which the craftsman worked and which resulted in an elegant family of joints designed so that the contact faces were always in compression. This in turn resulted in limiting the use of timber to solid beams and compression members, producing heavily unwieldy structures which wholly failed to express the true qualities of the material. Timber is from two to three times as strong in tension as it is in compression, its outstanding structural quality is its high strength in relation to its mass, it is hardly affected by fatigue and is admirably suited to structural uses involving high reversals of stress—but nothing of this was reflected by the heavy and clumsy technique of traditional construction in timber.

Structural engineering is almost wholly a matter of making joints of one sort or another, and a jointing technique which cannot be mechanised will find no place in modern production. The Code of Practice has limited its recommendations to joints which lend themselves to modern production methods, which will develop the properties of the material in bending, compression, tension and shear, and which will encourage the development of prefabrication techniques to which timber is suited.

Types of Jointing

In order of structural efficiency the jointing materials available to the timber engineer are:—

(i) Adhesives.
(ii) Timber connectors, and
(iii) Nails, screws and bolts.

(i) **Adhesives** of the synthetic resin type have brought gluing techniques within the range of engineering workshop practice. Joint efficiencies of the order of 100 per cent. were possible with the older adhesives of organic origin, but they suffered from exposure to moisture as well as from attack by micro-organisms. Resin adhesives are now available which are immune from these causes of deterioration. Structurally they achieve for timber what welding has achieved for steel, and although insufficient time has elapsed to guarantee their everlasting durability, certain of the resins have displayed but negligible ageing effects over experimental periods of from ten to fifteen years.

The Code of Practice provides that the permissible shear stress for adhesives in simple lap joints shall be taken as being equal to the basic stress in shear parallel to the grain of the timber used. This is probably a conservative rule but the distribution of shear over a lap joint of the kind shown in Fig. 1 is by no means easy to determine. In this kind of joint the maximum stress occurs at the edges and may be many times as great as the apparent shear stress obtained by simply dividing the load by the contact area. The ratio of the maximum actual stress to the apparent stress is determined by the geometry of the joint, i.e. the relation of the

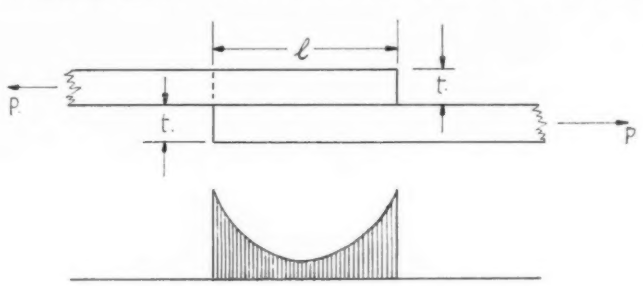


Fig. 1 (top left). simple overlap showing distribution of shear stress.

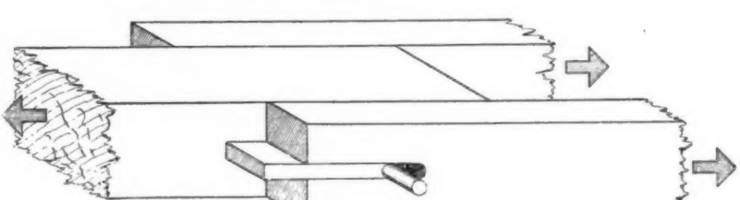


Fig. 2 (bottom left). Shear failure at end of tension joint.

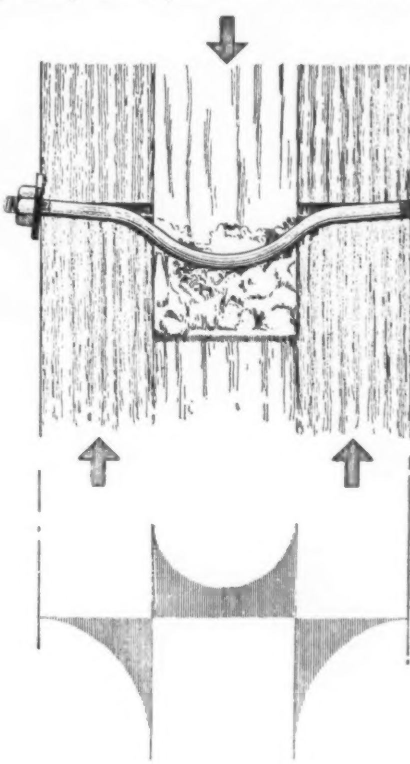


Fig. 3 (right). Stress distribution under deformed bolt.

Structural Timber for Dock Work—continued

thickness of the material to the length of over-lap, and by the elastic properties of the glue and the wood. The writer has suggested* the following formula for determining the permissible apparent shear stress:

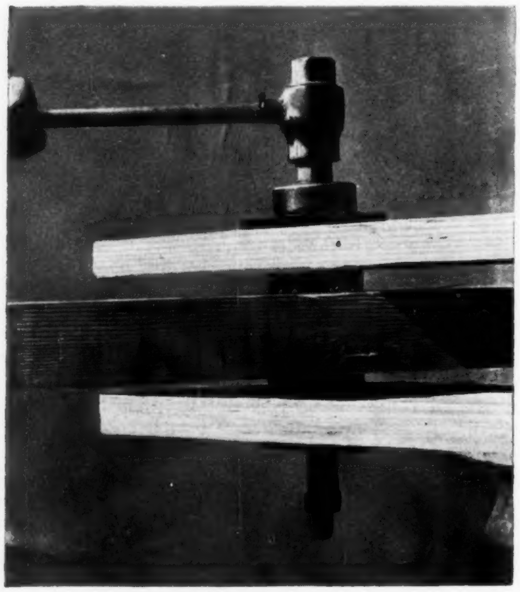
$$u = \frac{3v\sqrt{t}}{l}$$

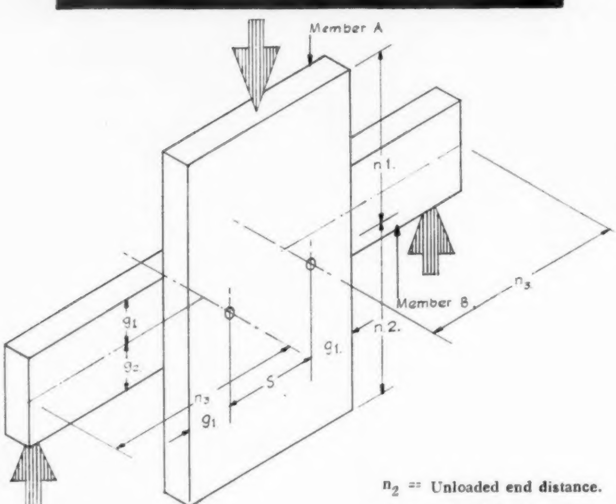
where

u = the permissible shear stress determined by dividing the load by the contact area. This may exceed v but should not exceed 1.5v.

v = the basic working stress in shear parallel to the grain of the timber used.

t = the thickness of the thinner of two members joined together in inches.





n_1 = Loaded end distance.

s = Spacing parallel to grain in member B. Spacing perpendicular to grain in member A.

n_2 = Unloaded end distance.

g_1 = Unloaded edge distance.

g_2 = Loaded edge distance.

n_3 = End distance for members loaded perpendicular to the grain.

(ii) **Timber Connectors.** In general these consist of rings or discs which, embedded partly in each of two adjacent members, transmit load from one to the other. Modern connectors may be classified as:

(a) Plates with teeth, spikes, or corrugations which are forced into the faces of the members to be joined.

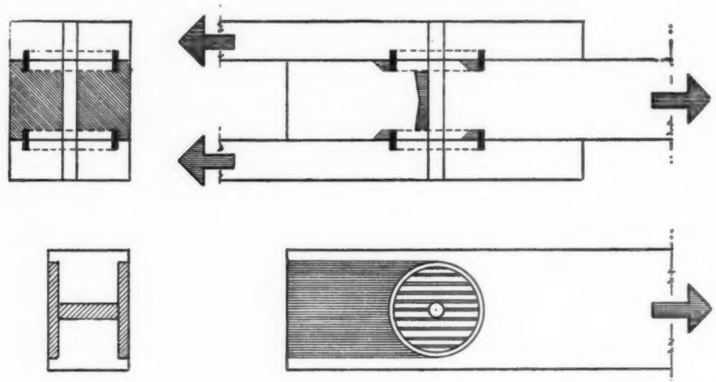
(b) Plain rings which fit into pre-cut grooves in the wooden members, or toothed rings forced in under pressure.

(c) Discs usually tapered each way from the middle of the thickness, fitting into pre-cut recesses half in one member and half in the other.

Timber connectors afford a joint efficiency lower than that of adhesives, usually of the order of 60 to 80 per cent., but they have the advantages that they do not require the same degree of factory control, the equipment needed is of a simple kind, the operations involved are amenable to ordinary building workshop practice and can if necessary be executed *in situ*; the structures they produce are generally demountable and individual components can be designed to be taken out and replaced without difficulty.

(iii) **Nails, screws and bolts.** This type of connection may give

Fig. 4 (top left) Toothed connector embedded with ball-bearing washer assembly. Fig. 5 (bottom left) Standard dimensions in the design of joints. Fig. 6 (above) Split-ring connector and groove-cutting tool. Fig. 7 (below) Stress distribution of split-ring connector.



a joint efficiency as low as 15 per cent. owing to the physical difficulty of accommodating a sufficent number of units in the contact area of the members to be joined. Nailing has the advantages of tradition and simplicity, and by pre-boring the holes it is possible to develop a fairly efficient structure characterised by wide, thin members such as may be employed in nailed built-up girders.

The main reasons for the low efficiency of the rigid-bar type of connection such as the nailed or bolted joint are:

(a) The low shear strengths of timber parallel to the grain, permitting failures of the type shown in Fig. 2.

(b) The non-uniform distribution of bearing stress along the shank of the nail or bolt, etc. In steelwork it is usually assumed

Structural Timber for Dock Work—continued

TABLE 1.—PERMISSIBLE LOADS FOR ONE DOUBLE-SIDED ROUND TOOTHED-PLATE CONNECTOR (WITH TIMBER SIDE PLATES).

Connector dia.	Bolt dia.	Thickness of member		Load parallel to grain (lb.)		Load perpendicular to grain (lb.)	
		Connector on one side only	Connectors on both sides on the same bolt	Group I	Group II	Group I	Group II
		1	2				
2"	½"	2" & over	4" & over	1280	1010	1135	820
2½"	½"	2" & over	4" & over	1440	1140	1295	950
3"	½"	2" & over	4" & over	1605	1270	1460	1080

that bearing stress is uniformly distributed over an area equal to the plate thickness multiplied by the bolt diameter, the effect of any error in this assumption being minimised by the fact that the plate thickness is not very large by comparison with the bolt. In timber this is not the case; thicknesses are usually large in relation to diameters and the deformation of a bolt is accompanied by a stress distribution of the kind illustrated by the shaded diagram in Fig. 3. It is this stress distribution which provides the main argument in favour of the modern timber connector: the connector is in effect a short dowel of large diameter placed at the point of maximum stress in the contact faces, thus avoiding the depletion of those parts of the cross-section where there is little load to carry.

Timber Connectors

The types of connector for which design rules are provided in the Code of Practice are described in British Standard 1579: 1949—"Connectors for Timber." They are broadly of two kinds: toothed-plates and rings, each class being adapted for both timber-to-timber connections and for timber-to-steel.

Toothed-Plate Connectors. These connectors are made from circular or square steel plates of from 20 to 18 S.W.G. cut and stamped to provide projecting triangular teeth which are embedded in the surfaces of the timbers to be joined, the teeth being forced into the timber by pressure developed through a high-tensile steel bolt with ratchet spanner and ball-bearing washer assembly as shown in Fig. 4.

For timber-to-timber joints the connectors are "double-sided," i.e. with teeth on both sides of the plate. For timber-to-steel joints "single-sided" connectors are used with teeth on one side only, the load being transmitted from the connector to the steel side by bearing on the bolt, a flange being formed in the connector to give the necessary bearing area.

The Code of Practice lays down design rules for round toothed-plate connectors of 2-in., 2½-in. and 3-in. diameter and square connectors of 2-in. and 3-in. sides, the safe-working loads for which, when used in conjunction with group I and group II timbers are given in tables 1 and 2.

TABLE 2.—PERMISSIBLE LOADS FOR ONE DOUBLE-SIDED SQUARE TOOTHED-PLATE CONNECTOR.

Connector dia.	Bolt dia.	Thickness of member		Load parallel to grain (lb.)		Load perpendicular to grain (lb.)	
		Connector on one side only	Connectors on both sides on the same bolt	Group I	Group II	Group I	Group II
		1	2				
2"	½"	2" & over	4" & over	1270	1130	1125	940
3"	½"	2" & over	4" & over	1910	1770	1765	1580

Owing to the marked difference between the strength properties of timber parallel and perpendicular to the direction of the grain, design rules for the permissible loading and spacing of connectors in a joint are considerably more complicated than for say a riveted joint in steel. The Code sets out the design requirements in some detail and all that will be attempted here will be to outline some of the more important considerations.

Fig. 2 illustrates the kind of failure which can occur at the end of a tension joint. Obviously the material between the bolt and the end of the members is under load, and owing to the low shear strength of timber this is an important consideration. If the assembly shown were subjected to compression instead of tension the material between the bolt and the ends of the members would not be sustaining any load at all, and consequently the distance between the bolt and the ends would be comparatively unimportant. In the first case the end distance is defined by the Code as a "loaded" end distance, and for the second case as an "unloaded" end distance. Other dimensions governing the design of joints with mechanical fixings are illustrated in Fig. 5.

Split-Ring and Shear Plate Connectors.

The split-ring connector is a split circular band of steel—not unlike a piston-ring which is placed in grooves cut in the contact faces of the timber members to be joined, the assembly being held together with a connecting bolt. The grooves are pre-cut with a power tool, as shown in Fig. 6. The purpose of the split in the ring is to permit simultaneous bearings against the core inside the ring and against the wood outside the ring, giving the stress distribution indicated by the shaded areas in Fig. 7.

Ring connectors are essentially "double-sided" in that they have to be embedded in grooves cut in the members on both sides of the joint. Where a "single-sided" connection is required with a strength comparable to that of the split-ring a shear plate is used. This may be of either pressed steel or malleable cast-iron and consists of a circular flanged plate which is placed in a pre-cut recess in the timber. Load is transmitted from the timber to the metal flange and thence by metal-to-metal bearing on the connecting bolt. These connectors lie flush with the surface of the wood component and are therefore very suitable for demountable structures and for factory-made components intended for site assembly, the connectors being nailed into their recesses to prevent loss in transit (see Fig. 8).

TABLE 3.—PERMISSIBLE LOADS FOR ONE SPLIT-RING CONNECTOR UNIT.

Split-ring dia. (in.)	Bolt dia. (in.)	Arrangement of connectors	Thickness of member (in.)	Load parallel to grain (lb.)		Load perpendicular to grain (lb.)	
				Group I	Group II	Group I	Group II
2½	½	Connector on one side of member only	1⅝ & over	2975	2500	2105	1750
			1	2480	2080	1750	1460
		Connectors on both sides of member, on the same bolt	2 & over	2975	2500	2105	1750
			1⅝	2480	2080	1750	1460

TABLE 4.—PERMISSIBLE LOADS FOR ONE SHEAR-PLATE CONNECTOR UNIT.

Shear-plate dia. (in.)	Bolt dia. (in.)	Arrangement of connectors	Thickness of member (in.)	Load parallel to grain (lb.)		Load perpendicular to grain (lb.)	
				Group I	Group II	Group I	Group II
2⅝	¾	Connector on one side of member only	1⅝ & over	3155	2630	2210	1840
		Connectors on both sides of member, on the same bolt	2 & over	2980	2485	2085	1740
			1⅝	2455	2045	1715	1430

Structural Timber for Dock Work—continued

TABLE 5.—WIRE NAILS. PERMISSIBLE LATERAL LOAD WHEN INSERTED AT RIGHT ANGLES TO THE GRAIN.

Size of nail		Penetration of nail (in.)	Permissible lateral load (lb.)	
S.W.G.	Diam. (in.)		Group I	Group II
18	0.048	½	17	14
17	0.056	⅝	22	18
16	0.064	¾	27	22
15	0.072	⅞	32	26
14	0.080	1	37	31
13	0.092	1⅛	46	38
12	0.104	1¼	55	45
11	0.116	1⅜	65	53
10	0.128	1½	76	62
9	0.144	1¾	90	74
8	0.160	2	106	86
7	0.176	2¼	122	100
6	0.192	2⅝	139	114
5	0.212	3	161	132
4	0.232	3¼	184	151
3	0.252	3½	209	171
	5/16	4⅜	288	236
	⅜ in.	5¼	379	310

TABLE 6.—WOOD-SCREWS. PERMISSIBLE LATERAL LOAD WHEN INSERTED AT RIGHT ANGLES TO THE GRAIN.

Size of screw		Penetration (in.)	Permissible lateral load (lb.)	
Gauge	Diam. (in.)		Group I	Group II
4	0.108	¾	46	38
5	0.122	⅞	59	48
6	0.136	1	73	60
7	0.150	1 1/16	89	73
8	0.164	1⅛	107	87
9	0.178	1¼	125	103
10	0.192	1⅜	146	119
11	0.206	1½	168	137
12	0.220	1⅝	192	157
14	0.248	1¾	244	198
16	0.276	2	302	247
18	0.304	2⅛	366	300
20	0.332	2⅜	436	357
24	0.388	2¾	596	488
28	0.444	3⅛	781	639
32	0.500	3½	990	810

The safe working loads and spacing for split-ring connectors and shear plate connectors are given in tables 3 and 4.

Nails and Screws

It is not generally realised that nailed and screwed joints are as amenable to calculation as any other kind. Their strength and holding power depends on a number of factors, the type of nail or screw, its diameter and depth of penetration, its direction relative to the grain of the timber, the manner in which the load is applied, the use of pre-bored holes, the moisture content and density of the timber, and in the case of nails whether they are clenched or not. This is a formidable list but in spite of this the design of such joints is simple enough in practice.

TABLE 7.—SPACING OF NAILS OR SCREWS.

Distance or spacing	Nails or screws driven without pre-boring	Nails or screws driven into pre-bored holes
End distance	20D	10D
Edge distance	5D	5D
Side spacing between lines of nails	10D	3D
Spacing between adjacent nails	20D	10D

where D = diameter of the rail or screw.

TABLE 8.—BOLTS. PERMISSIBLE LOAD ON ONE BOLT IN A TWO-MEMBER JOINT (LB.).

Thickness of thinner member (in.)	Diameter of bolt (in.)	GROUP I		GROUP II	
		Parallel to grain P	Perpendicular to grain Q	Parallel to grain P	Perpendicular to grain Q
1	½	575	275	385	150
	⅝	770	310	480	170
	¾	930	350	575	190
	⅞	1090	385	670	210
	1	1250	420	770	230
1½	½	630	415	490	230
	⅝	970	470	695	260
	¾	1295	535	860	290
	⅞	1595	575	1010	310
	1	1855	630	1150	340
2	½	630	485	490	300
	⅝	985	625	770	340
	¾	1415	695	1075	385
	⅞	1865	770	1310	420
	1	2310	840	1530	455
3	⅝	985	665	770	450
	¾	1415	925	1110	570
	⅞	1925	1130	1505	630
	1	2515	1260	1975	685
	1⅛	3200	1370	2420	745
4	⅝	985	590	770	430
	¾	1415	865	1110	600
	⅞	1925	1165	1505	785
	1	2515	1475	1975	910
	1⅛	3200	1765	2500	995
	1¼	3930	1910	3085	1070
6	1	2515	1310	1975	940
	1⅛	3200	1690	2500	1175
	1¼	3930	2075	3085	1490

Load may be applied to a nail or screw as shown in Fig. 9, which illustrates:

(a) Withdrawal from side grain.
(b) Withdrawal from end grain.
(c) Lateral load on side grain.
(d) Lateral load on end grain.

So far as possible nailed and screwed joints should be designed to withstand the loads illustrated in (c), i.e. with lateral load on side grain. The safe loads recommended by the Code for this condition are shown in tables 5 and 6.

As will be seen from these tables there is no very significant difference between the strength of nails and screws of the same diameter, the advantages of the latter being only in strength of withdrawal, and in the smaller penetration required to attain the same permissible lateral load.

In general the main objection to the structural use of nails and screws is the very large number which usually have to be accommodated in a joint. Table 7 shows the spacing requirements which

Structural Timber for Dock Work—continued

normally determine whether nailing or screwing offer practical solutions, a point worthy of note being the very considerable reduction in spacing allowed by the use of pre-bored holes for both nailing and screwing. When pre-boring is employed the holes drilled should be not greater than 4/5ths of the diameter of the nail, or 7/8th the diameter of the root of the thread adjacent to the shank of a screw.

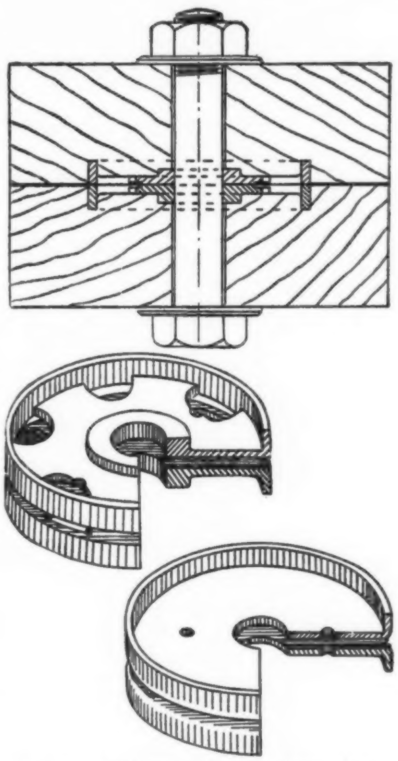


Fig. 8. Cast-iron and steel shear plate connectors.

Bolts.

Bolted joints are perhaps the most familiar although there has been little uniformity in practice. The loads recommended in Table 8 are for one mild steel bolt in single shear in a two-member joint. For multiple-member joints where bolts are in double or quadruple shear, the safe loads may be multiplied by two or four as the case may be, the permissible load being taken as the sum of the recommended loads on each shear plane.

The spacing of bolts is governed by the relative thickness of bolt and timber and by the direction of the load in relation to the grain. Broadly, the detailed recommendations of the Code give the following results:

(i) Spacing in direction of load = 4 diameters.
(ii) Loaded end distance = 7 diameters.
(iii) Unloaded end distance = 4 diameters.
(iv) Unloaded edge distance = $1\frac{1}{2}$ diameters.
(v) Loaded edge distance = 4 diameters.
(vi) Spacing at right-angles to direction of load for loading perpendicular to grain = nd.
where $n = 1\frac{1}{4}\ t/d + 1\frac{1}{4}$ and
t = thickness of timber.

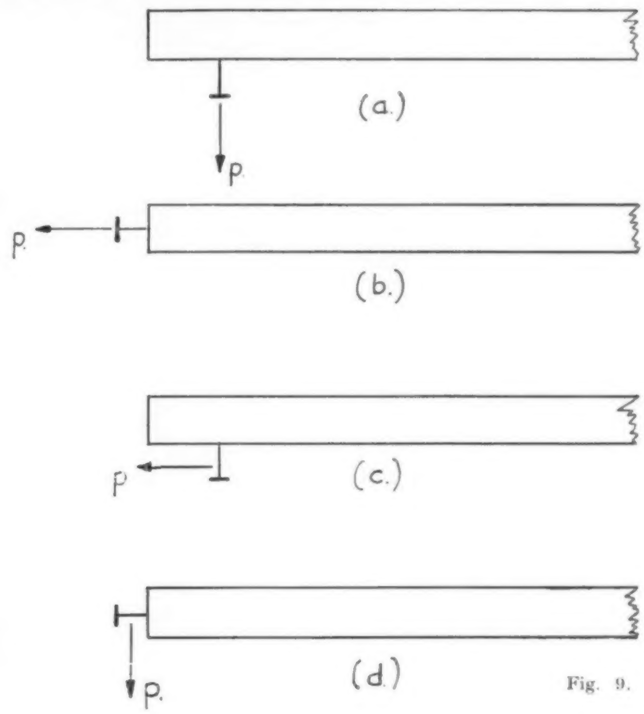


Fig. 9.

TABLE 9.—MODIFICATION FACTOR K FOR JOINTS.

Type of loading	Modification factor K
Dead load plus superimposed load	1.00
Dead load plus superimposed load plus snow load	1.125
Dead load plus superimposed load plus wind load	1.25
Dead load plus superimposed load plus snow load plus wind load	1.25

(vii) With loading parallel to the grain the spacing at right-angles to the grain will be determined by the fact that the net area of timber at a critical cross-section shall be not less than 4/5th of the sum of the areas in bearing under all the bolts in the member at the joint.

Wind and Snow Loading

The Code provides that the recommended safe loads on all joints may be multiplied by the modification factors shown in Table 9.

Timber Development Association

Publications Recently Issued

Statistical Year Book and Port Analysis

Owing to the difficult trading conditions which have existed since the War, the timber trade and timber using industries have found it more and more necessary to have recourse to and build on official statistics.

In order to meet the demand for such information, graphs and tables have been issued periodically by the Timber Development Association. In their Statistical Year Book for 1951, the Association now presents this material within the covers of a book. Included are U.K. imports, production, consumption and stocks of timber for a number of years, together with summaries showing the value of all U.K. imports for 1949-51. These facts are illustrated in a series of 17 table, for easy reference.

Copies of the Statistical Year Book, price 2s. 6d. each, can be obtained on application to the Association at 21, College Hill, London, E.C.4.

Timber and British Ports

The second edition has just been issued of a useful and well arranged analysis on timber supplies, entitled " United Kingdom Timber Imports: Port Analysis." In this two-page chart, every port in the country handling timber is listed, together with the exact quantity and value of every type of timber arriving at each in a typical pre-war year—1938, and in 1951.

The statistics, extracted from official records of H.M. Customs and Excise, are not published in any other document or publication; printed copies of the tables are obtainable from the Association, at a cost of 6d. per copy. If ordered as an addendum to the Statistical Year Book, there is no charge.

Tug Wanted For Otago Harbour.

The Otago Harbour Board, New Zealand, has called for tenders for the building of a twin-screw tug and salvage vessel.

The Liverpool Observatory and Tidal Institute

Excerpts from Report for 1952

Dr. R. H. Corkan.

The very unexpected death of Dr. R. H. Corkan, Deputy-Director of the Institute, at the early age of 45, brought to a close a career of high attainment and of much promise. After completing his education at the University of Liverpool, where he obtained an Honours degree in mathematics, he was selected as scientific assistant at the time of the transfer of the Tidal Institute from the University to the Observatory, in January, 1929.

His first research work in association with Dr. Doodson, the Director of the Institute, led to the construction of cotidal charts for the English and Irish Channels in continuation of a similar work by Proudman and Doodson for the North Sea, and all these are combined in the Admiralty Chart of cotidal lines for British Waters. Again working with Dr. Doodson, the next research dealt with the yielding of the earth to the load of tidal waters and also directly to the attractive forces of sun and moon, and this work had been followed up by him up to the time of his death. He published papers on the Bore in the Trent, tides near Graham Land and on analytical problems.

The war put a stop to many of his tidal researches and he was seconded to the Admiralty. After the war he resumed his interest in the storm surges experienced in the North Sea. The disastrous floods in the Thames, in January, 1928, led to Dr. Doodson being asked to investigate the causes and this work was followed up by Corkan in a very comprehensive manner. The earlier results were confirmed and methods of calculation were elaborated for many types of barometric distribution and the result was that a full report was prepared for the London County Council, the Port of London Authority and others. A brief description of this work was published in *The Dock and Harbour Authority*,* and the whole report in two volumes was photographically reproduced by the United States Hydrographic Department and distributed in that country.

Publications.

During the year the following publications have appeared:—

"New tide-predicting machines" (A. T. Doodson, *International Hydrographic Review*, Monaco, Vol. XXVIII, No. 2, November 1951).

"The tides: Numerical methods of analysis" (A. T. Doodson, *The Times Review of the Progress of Science*, No. 3, Spring 1952, p.8).

"Further observations of the turbulent fluctuations in a tidal current" (K. F. Bowden and L. A. Fairburn, *Philosophical Transactions of the Royal Society*, No. 883, Vol. 244, pp. 335-356, 1952).

"Free tidal oscillations in a rotating square sea" (R. H. Corkan and A. T. Doodson, *Proceedings of the Royal Society*, A, Vol. 215, pp. 147-162).

"Report of Committee on Mean Sea-level and its variations."

"Further investigations of North Sea Surges" (R. H. Corkan).

"Storm effects in the Irish Sea" (R. H. Corkan, *Assoc. Oceanogr. Phys., Proces-Verbaux* No. 5, pp. 67, 167, 170).

The first of these publications is largely an extract from the Annual Report for 1950 and it describes the Doodson-Légé Tide-Predicting machine acquired by the Tidal Institute. Copious extracts from the Reports of the Tidal Institute have also appeared in *The Dock and Harbour Authority*. The article in *The Times* science review is a general account of the progress which has been made in reducing to law the tidal phenomena, whether in harbours or in the open sea. The paper by Mr. Bowden and Mr. Fairbairn, both of the University Department of Oceanography, describes the results of the observations made jointly with the Observatory staff in the River Mersey, using the Doodson current meters, as described in the Report for 1949.

*See February 1948 issue.

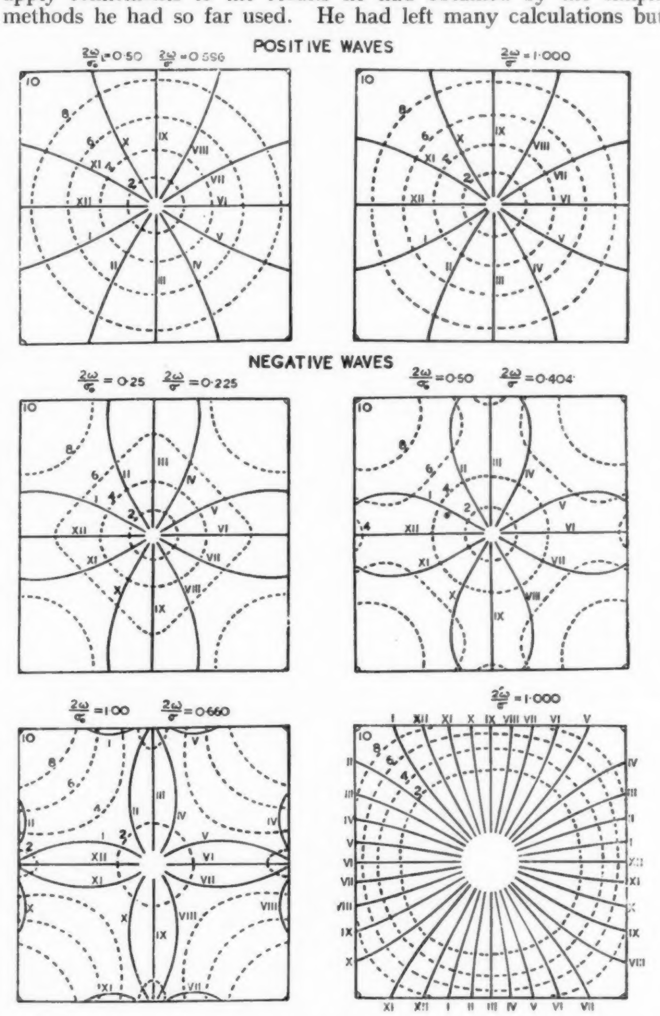
The paper on free tidal oscillations in a square sea was referred to in the Report for last year, but will be further described later.

The last three items are brief extracts of lectures from the proceedings of the meeting of the Oceanographical Section of the International Union for Geodesy and Geophysics, held at Brussels last year. The investigation on the storm effects in the Irish Sea has not yet been completed.

Research.

The death of Dr. Corkan has affected the course of the research work during the year. It seemed to be desirable to complete some of the work he had commenced while the details were still fresh in the minds of the staff. This has led to the postponement of the work on the tides in oceans which are bounded by incomplete meridians, approximating to the Atlantic Ocean, but it is hoped to resume this work at an early date.

Corkan had done a great deal of work on the free tides in a square sea on a rotating earth, mainly by way of exploring the methods of iteration by finite differences, and he had begun to apply refinements to the results he had obtained by the simple methods he had so far used. He had left many calculations but



very little description, so that it was necessary for the Director to revise the whole of the work. It was pointed out last year that the ultimate object of the investigation was the application of similar methods to the free and forced tides in actual seas and the introduction of additional theory into the methods used in the preparation of cotidal charts. In the course of this revision some points of very great theoretical interest emerged. One was in relation to what is known as Rayleigh's Principle, which has been extensively used in the application of similar numerical methods to engineering problems. The tidal problems are more complex than these because of the rotation of the earth, which involves the interactions of tides in two phases, and the expression of Rayleigh's

Liverpool Observatory and Tidal Institute—continued

Principle is more complex than would be in the case of the absence of rotation. By integrating the mathematical expressions from coast to coast it was shown that they were identical with the direct and simple integrations of the differential equations over the whole sea after applying the " least square rule " so as to give the "best" values of the constants of the equations.

Another important result was the tendency of tidal oscillations which rotate round the sea in the opposite sense to that of the bodily rotation of the sea to be annulled or to be reversed in direction of rotation, whatever the degree of rotation. Some general reasoning was given to show why this must be so, and it was deduced that negative waves could only exist if the two phases had equal amplitudes. Even in such cases the effects were also seen in the results of the calculation. The drawings show the cotidal and co-range lines for two cases of positive waves (those rotating in the same directions as the rotation of the sea) and for four cases of negative waves. The degree of rotation of the sea increases with the constants given at the top of each diagram. The positive waves are not greatly affected by the degree of rotation of the sea, but the negative waves change rapidly. The third negative case shows that though there is a negative wave in the centre of the sea there are systems of positive waves developing on the boundaries and in the corners, while the last negative case shows that the fundamental negative oscillation has been annulled by the rotation.

Some five years ago the Director had the privilege of showing a film on ocean tides to the Hydrographic Conference at Monaco. This film was made from drawings executed by a Dr. Barton, and it graphically depicts the progress of the tide in British waters and in two of the main oceans. The cotidal charts used by Barton, however, were very imperfect, though they served to demonstrate the complexity of the phenomena and had instructional value. The Director has long had in mind a project for revising this work, particularly in the use of the accurate cotidal and co-range charts which were prepared by him in association with Professor Proudman and Dr. Corkan many years ago for British waters. A start has now been made on this work by the Director and Mr. Lennon, but it is curious that at the same time the owner of the film referred to has undertaken to supply copies of the film, a matter which had been urged by the Director on many occasions during the last five years. A copy of this film has been purchased but the work of revision will still go on, possibly in collaboration with the owner of the existing film. The Director is prepared to answer queries as to this subject for when he showed the film many hydrographers overseas were anxious to obtain copies.

International Hydrographic Conference.

The Sixth International Hydrographic Conference was held in Monaco for the two weeks at the end of April. Most of the subjects discussed were non-tidal but there was a great deal of interest in the drawing of cotidal charts for seas and oceans and it was agreed to obtain all possible data from oceanic islands. It was considered to be impracticable to construct these charts by international co-operation as the theoretical difficulties of such constructions are still very great so that much research, similar to that which has been carried out at the Tidal Institute, still remains to be done.

A theoretical matter of some importance in the analysis and prediction of tides also came under discussion. This was a German proposal that the fullest possible use be made of the development of the tidal forces made by the Director in the year 1921. The matter was referred to a small committee for a report to the International Bureau.

It was interesting to learn that the Admiralty Manual of Tides, by Doodson and Warburg, is increasingly valued by all nations, and that in addition to the translations already made into other languages, two others were being made.

Predictions for Almanacs.

The supply of predictions to almanacs, and to private publishers, has continued to increase. In many cases the required predictions are for the most important ports, especially Liverpool and London. The Institute is highly privileged to be able to supply publishers with copies of predictions which have been prepared for the Hydrographic Department and for tidal authorities in the Dominions and Colonies. The friendly relations which exist with many foreign hydrographic authorities also permit of an exchange of publications and the Institute is thus allowed to supply publishers with copies of the officially accepted tables. The Institute does not prepare a special prediction if an official one exists. It is the policy of the Institute to supply only predictions of the highest possible merit even though such predictions are more costly than many publishers like, but a large number of publishers have come to realise the benefits received through this policy.

Book Reviews

" The Port of London Guide." By Frank C. Bowen. Coram (Publishers) Ltd. 25s. net.

The new and completely revised edition of the " Port of London Guide " is a mine of information for those who have business in the Port of London.

Of particular use is the directory of wharves. The names and addresses of about 600 of the more important wharves are given alphabetically and against each entry is a reference number. Thus R-100/104 means that the wharf is on the right bank of the Thames and lies between place number 100 and place number 104 as shown in a table of distances measured from London Bridge.

There is in addition generous information concerning the Docks owned and operated by the Port of London Authority with a map of each of the five dock groups and directions on how to reach the docks from the City.

Apart from the Port Authority there are other public bodies with responsibilities in the Port of London and details of their work are dealt with in such sections of this publication as Port Health, Immigration, Customs, Pilotage, River Police, etc.

Services carried out by private enterprise are dealt with in chapters on Repair Facilities, Bunkering, Tug Owners, Lighterage, etc. Information is given regarding the Interpretation of Trade Terms as applied to the Port of London, on ferries and on Fire precaution and services.

There is a list of shipowners who despatch vessels on regular berth from London: a list of Shipping and Forwarding Agents and a general list of useful addresses of organisations providing services in the Port. A. G. T.

" The Sea Coast," by J. A. Steers, pp. 276 (incl. index), Figs. 52, plates in black and white, xxiv, plates in colour 8. Collins, 1953. Price 25s.

This book is the 25th in the New Naturalist Series which, in the words of its editors, is intended to interest the general reader in the wild life of Britain by recapturing the inquiring spirit of the old naturalists. It is not surprising that the high standard achieved in the earlier volumes of the series is here well maintained, since the author is Professor of Geography in the University of Cambridge.

A description of the sea coasts of Britain is given from the physiographical standard. The main themes are: (1) A brief synopsis of the relation of coast to the structure of the country and a summary analysis of the physical agencies working on the coast; (2) a discussion of the nature of different types of coastal scenery; and (3) a short account of the evolution of parts of our coastline. There is a final chapter on raised beaches and submerged forests.

The chapters on the movement of beach material, erosion and accretion, the formation of sand and shingle spits and salt marshes, and on major shingle structures will be of special interest to harbour and coastal engineers if only because of the ample evidence given that it is impossible to generalise. It is reassuring to learn, in a year of calamities, that normally accretion is far in excess of erosion; it should not be forgotten, however, that from the practical standpoint erosion often involves the wastage of invested capital, while the land which accrues to the country usually requires investment to make it usable.

There is a small slip on page 20 where it is stated that waves break in water the depth of which is approximately half the wavelength.

Book Reviews—continued

It would be more accurate to say that in British coastal waters waves break when their height is 1/1.28 of the depth of water, and that in these conditions the wavelength is of no importance. The thesis that there is movement of sea bed material in deep water during stormy weather is unaffected.

The many excellent figures and photographs, some aerial, enrich the text, while the author's colour photographs provide convincing reminder of the variegated splendours of our coastline. A. H. L.

"Marine Fouling and Its Prevention." Woods Hole Oceanographic Institution. Published by The United States Naval Institute. Annapolis, Maryland. 1952. (No price stated).

Although most of the readers of this Journal are presumably more concerned with stationary marine structures than with ships, they will undoubtedly have a general interest in fouling by marine organisms. It is, therefore, pertinent to draw attention to a recent publication of the United States Naval Institute entitled "Marine Fouling and Its Prevention." It should be said at once that this is an excellent book and by far the best general exposition of the subject that has yet appeared.

Fouling, as long generations of British seamen have known to their cost, is a major factor affecting the operation of vessels and may have a vital influence on the efficiency of fighting ships. During the Second World War the prevention of fouling, particularly of units operating in tropical waters, became a major military problem. Consequently, concerted efforts were made by research workers both in Great Britain and in the United States to improve the available anti-fouling methods. Much of the American work, which was by far the larger in volume, was done at the Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, during the years 1940-1946. More than 50 trained investigators collaborated in these researches and the book represents a studied exposition of the results of their labour. Its success is fully indicated by the following sentence taken from page 3 of the book.: "Great improvements have been made in the coatings employed by the United States Navy, and it is reported that during the recent war in the Pacific it was found unnecessary to make allowances for fouling in estimating fuel requirements."

It is unnecessary to describe the contents in detail. They are classed under three heads: (I) Problems of fouling; (II) Biology of fouling; (III) Prevention of fouling.

In the last part a full account is given of the prevention of fouling by anti-fouling compositions and of the physico-chemical tests that have been developed for checking their efficiency.

As due cognizance has been taken of the parallel studies of British and other non-American investigators, the whole work constitutes an exhaustive survey of the fields so far explored. It is well written, well printed and well illustrated. Moreover, it is documented by several hundred references to original papers. It reflects great credit on all concerned in its production. J. C. H.

"Dry Rot and Other Timber Troubles." By W. P. K. Findlay. (Hutchinsons Scientific and Technical Publications 1953. 25s.).

If only those who use timber had even a nodding acquaintance with the principal facts contained in Dr. Findlay's book, there would be far less waste of timber and consequent loss to the nation than is the case at present. Timber is a first-class material which has proved its capabilities for a multitude of purposes from earliest times. But it asks to be used properly. Nobody uses iron or steel in damp conditions without protection by paint, galvanising, etc., without expecting rust. Timber is, however, often regarded as a non-durable material because most kinds do not last indefinitely when used unprotected. Not very clear thinking.

This book gives a straightforward account of the ills affecting wood and their prevention in a way that should be readily comprehensible to the intelligent layman. The author very rightly emphasises the importance of preventative action and, apart from chapters on the care of timber after felling and wood preservatives, gives measures to forestall the activities of each pest mentioned. Information is also given on curative-methods.

After an introductory chapter on the nature of wood comes a general discussion on causes of deterioration in timber; the table on page 36 is a useful summary of the main differences between the principal causes. Then follow chapters on fungal decay, discolouration and insect attack, the latter a concise but adequate account of the principal insects attacking timber (including termites) and their control.

Foresters and anyone interested in trees will find the chapter on diseases of standing trees useful, indeed those using home-grown timber especially would find it of practical value. There is also included an account of "brittleheart" occurring in certain tropical trees, the recognition of which is important in structural timber.

In the chapter on "Decay of timber in Buildings," Dr. Findlay is very much on home ground and deals exhaustively with dry rot and related fungi. He draws on his vast experience to give practical advice on causes and eradication, including the recent experimental use of antiseptic plaster.

Readers of the "Dock and Harbour Authority" will be particularly interested in the chapter "Decay in ships, boats and marine works." Here again the advice given is based on the author's experience during his 25 years with the Forest Products Research Laboratory. Perhaps the section dealing with the marine borers might have been fuller to suit the taste of readers of this Journal, but it was obviously necessary to keep a balance when covering so wide a subject.

The final chapter discusses decay, its prevention and treatment in various industrial uses of timber, vehicles, mining, cooling towers, packing cases, plywood, etc. There is much valuable information here.

All those interested in the best use of timber but do not feel like coping with a highly scientific treatise on the destructive agents of wood should have this very readable book by their elbow for constant reference. It only remains to say that the book is well illustrated and has a good index. B. A. J.

Foreign Publications Received

"Travaux Publics" the well known organ of French Civil Engineering and Concrete Construction still holds an important place in the front rank of technical publications. Throughout 1952 each monthly issue contained important articles of current professional interest and extensive summaries of allied publications; for example, pre-stressed concrete applied to port structures, aluminium bridge construction for ports, whilst two entire issues (May and June) were devoted to navigable waterways of France, comprising besides the construction and lay-out, details of modern equipment and innovations in the economic design of structures, lock gates, locks, pumping plant and river training. The issues were replete with sound technical information,, clear description and amply illustrated with photographs and working drawings; a feature in which this review excels.

"Technique Moderne-Construction." This French journal concerns itself with heavy Civil Engineering Construction and specialises in French colonial activities, massive concrete structures, barrages, bridges, railways and roads.

"La Houille Blanche" published at Grenoble in the shadow of the French Alps is one of the best known and informative of reviews on Hydraulic Engineering and Research, and maintains its high standard of production and subject matter. The Editors neglect no branch of technical hydraulics, from novelty problems propounded by the whimsical Professor Cyprien Leborgne to the most profound investigations of water motions and behaviour. The close association and collaboration with the Neyrpic Laboratories of Hydraulics of which Mr. Pierre Danel is also Director, is productive of interesting and scholarly articles in the solution of many practical problems that beset the hydraulic and maritime engineer. Each issue contains about 100 pages of text.

"Annales de l'Institut Technique du Batiment et des Travaux Publics." This monthly review is unique: it has no advertisements and usually comprises four to six papers each issue. These papers are written by specialists upon particular aspects and details of construction over a wide range of interests. There is also a thorough resume of technical publications and professional Institutions from world wide sources. The documentation extends to 400 technical periodicals, mostly foreign to France, and information and issues are available to all subscribers. R.R.M.

Salvage at Immingham Dock

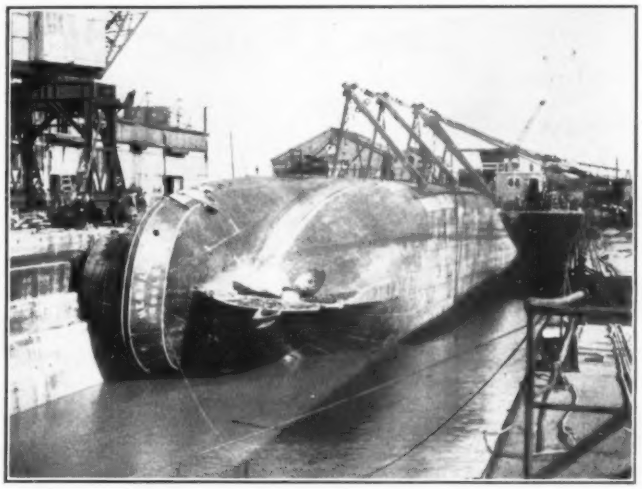
Ship Refloated After the Recent Floods

A successful salvage feat was completed on the Humber recently when the s.s. "Hebble," 1,078 gross tons, of the Association Humber Line, lying on her side in dry dock at Immingham, was brought to an upright position. This ship overturned in the dry dock during the night of gales and floods of January 31st last, when the force of water entering the dock, after the bank of the River Humber had been breached, knocked away the vessel's supports, thus submerging her.

After having pumped all the water out of the dry dock, the next task was to raise the s.s. "Hebble" to an upright position and refloat her. Four hinged steel masts were welded on to the starboard side of the hull, close to the bilge keel, to provide the necessary leverage; steel hawsers from these were passed through a series of pulley blocks and finally attached to one long steel rope which ran the full length of the Graving Dock, across the end, and thence to the railway sidings along the Immingham Dock side. Two locomotives supplied by the Eastern Region of British Railways were then run into the dock sidings and attached to the hawsers. The engines were used to provide a pull of about 6 tons which could be controlled and applied smoothly. As an anchor for the tackles the trawler "Deveron," loaded with gravel ballast in her fish hold, was alongside in the lock pit parallel with the dry dock. The uprighting tackles from the four masts were connected to heavy wire slings encircling the trawler. A heavy tackle from a capstan at the dry dock entrance lent a parbuckling effort and 150 tons of steel rails in the dry dock bottom provided damping to check the "Hebble's" ultimate upward swing.

The passage of the wire rope through the series of pulleys magnified the pull of the engines about 14 times at the ship end. To control the pull of the locomotives, a balance with a large dial indicating the pull was mounted on a small truck behind the tender of the first engine, one side being coupled to the tender draw hook and the other side to the wire rope. To enable the dial to be seen from the footplate, mirrors were mounted on the truck.

The control centre of the whole operation was established on the roof of a building at the end of the dry dock near to the bows of the "Hebble." Distance and intervening buildings and other structures rendered visual signalling impossible, no clear line of sight existing between the control position, the capstan and the locomotives. A communication system was therefore necessary between these three main points to ensure a successful operation. This problem was solved by the provision of three Marconi Marine VHF radiotelephone transmitter/receivers and three "Jericho" power megaphones.



The s.s. "Hebble" on her side in the Immingham Dry Dock with water being admitted to the dock at the commencement of the righting operations. The control point from which th operation was directed is seen on the roof of the building at the head of the dock.

The control position was equipped with a "Seaphone" VHF installation, while a "Harbafone" transportable set was placed on the rear locomotive. A van equipped with a "Seaphone" was parked between two buildings near the capstan and a 100-ft. lead was taken from the van to a loudspeaker, microphone and switching unit at the capstan position. "Jericho" power megaphones were used for speech communication between the control position and men inspecting the snatch-blocks and hawsers to ensure that no fouling occurred during the operation.

After coupling up, the engines moved slowly forward until all the slack in the wire ropes had been taken up. Water was gradually let into the dry dock and the engines continued to move slowly, exerting a steady pull. As the ship moved over, more water entered, and by controlling the movement of the engines and the level of the water, the vessel became more buoyant until she floated in an upright position.

The entire operation was carried out in less than an hour, and proved completely successful. Great credit is due to all concerned in the operation and especially to the Humber Graving Dock and Engineering Co., who provided all the gear and organised the communication arrangements.

National Association of Port Employers

Chairman's Report at Annual General Meeting

At the annual general meeting of the National Association of Port Employers, held in London last Friday, Sir Colin S. Anderson, a director of the Orient Line, was re-elected chairman. Sir John Hobhouse, M.C., partner in Messrs. Alfred Holt and Co., of Liverpool, and Sir Leslie Roberts, C.B.E., chairman of the Manchester Ship Canal Company, were re-elected vice-chairmen. Mr. Leslie Ford, O.B.E., general manager of the Port of London Authority, was elected treasurer, in succession to Sir Douglas Ritchie, M.C., who had resigned.

In presenting the annual report, Sir Colin Anderson referred to the continued heavy under-employment in the docks industry. He pointed out that the purpose of the Dock Workers (Regulation of Employment) Scheme was to promote full employment by maintaining the labour force at the level required to meet the industry's demands. This it had failed to do over the last 18 months, with two results, that the available employment was spread out too thinly over the labour force, with a depressing effect on earnings, and that an unreasonably heavy burden was placed on the industry in the extremely high levy on employers to cover the maintenance of redundant labour. It was high time a formula was found for adjusting the labour force to long-term requirements, and he believed that, with good will and foresight, it could be found. The Release Scheme of the National Dock Labour Board was an expedient but did not meet the real need.

Dealing with the turn-round of shipping, Sir Colin said that there had been an over-all improvement in turn-round, although there were still obstacles to maximum efficiency. The labour shortages of the past had put too much strain on the good workers, and had given the malcontents — a small minority — a chance to engineer all sorts of artificial stoppages. There was a good deal of uninformed comment on shipping turn-round, and a tendency to pin the blame—sometimes where none existed—on port employers and workers. It was mainly in order that the various factors involved in turn-round could be properly assessed that the Association had supported the idea of national statistics of turn-round, as proposed by the Minister of Transport.

The Association was sponsoring residential courses for foremen—an entirely new departure in the industry. The response to the scheme showed that the employers were alive to the need to encourage more efficient management, in which the foreman played so important a part.

The past year had been one of comparative peace in the docks industry. Of course, there had been and must be disputes, but the conciliation machinery of the industry—as effective and speedy as any—had adequately dealt with them. It would always do so if it were allowed to function.

Tank Cleaning Dangers

Efficacy of New Method

By GEO. B. LISSENDEN, M.Inst.T.

Disastrous petrol fires at docks which occur from time to time, call attention to the dangers attendant upon the transport and storage of such liquids in bulk.

During the Second World War, any dock worker who had anything to do with highly inflammable spirit was fully aware of the anxieties connected with the handling of this class of cargo. At Bromborough Dock, for instance, large tankers used to enter that dock to discharge their cargoes into nearby underground storage tanks and until those vessels were emptied, gas-freed and had put to sea again, all concerned had to be on the qui vive lest someone unthinkingly lit a cigarette or did something equally foolish.

Even with edible oils, there is also an element of danger, as the following facts make abundantly clear.

Palm oil was originally produced by the West African natives in a very crude manner and sent to this country in barrels, but during the last two or three decades—thanks to British foresight and ingenuity — the "on the spot" extraction of the oil from the palm kernel has become a highly specialised process, and a large proportion of the oil is now shipped to England in bulk.

The discharge of such a cargo is simple enough, but after the oil has been pumped ashore the ship's tanks have to be cleaned—scraped, then wiped down with rags soaked in paraffin—so that before she leaves for her next outward voyage, package cargo can be loaded into her with no fear of damage en route. As the tanks are still warm when the oil has been discharged, the men who go down to clean them wear very little; a singlet and a pair of shorts, or just the shorts and, as a rule, sacking tied round their feet to prevent them from slipping. Shoes are not worn lest a nail in the sole should strike against the steel bottom of the tank and cause a spark to germinate.

Close up of Separating and Heating Tank, mounted on trailer.

Oil tank lap jointed plates. Discosure of pitting in vicinity of rivets after cleaning to true metal by Groom system.

In February, 1933, the s.s. *Tasmanic* entered the Bromborough Dock with a general cargo of West African produce, including several hundred tons of bulk palm oil in her for'ard tanks—which tanks were fitted with heating coils so that hot water from the ship's boilers could be circulated through them during the voyage to keep the oil in a liquid condition.

Fourteen men were sent down into the for-ard tank in number 2 hatch of the *Tasmanic* as soon as it was cool enough for them to begin cleaning it, and buckets of paraffin—the best known solvent for removing the residue of palm oil from any receptacle—plus bundles of clean rags, were lowered down into the tank for the men to use.

Shortly afterwards a fire broke out; as a result of which four of those 14 men lost their lives; two were terribly burned; and two others slightly so. The origin of the fire was never discovered.

A Safe and Efficient System of Tank Cleaning.

Since that date, a new system has been invented which, it is claimed, has solved the problem. The use of aqueous detergent solutions for removing oil deposits from tankers or other vessels has not hitherto been pursued on account of the formidable areas to be cleaned and the high consumption of detergent involved, which rendered such methods too costly, apart from the practical difficulties. By means of the new method, however, hot detergent is projected against dirty surfaces and accumulations of sludge, and returns the whole to a separating tank. This small but scientifically designed installation separates and recovers the burnable or usable oil from the solids in the sludge such as sand, rust, scale and asphaltic concrete particles, and entirely separates and reheats the detergent for immediate re-circulation to the operating projectors, so the loss of detergent, theoretically nil, is in practice negligible.

The system provides for the complete plant, mobile or static, to be at the site and consists of:—

- Separating and heating tank, complete,
- Steam operated detergent pump.
- Air operated return pump (or pumps) with de-aerator,
- Manual or automatic projectors,
- Hoses and fittings.

Detergent powder is mixed with water to charge the tank, where it is heated and pumped down to the projectors, cleaning the surfaces and liquifying the accumulation of sludge, the whole arisings from which are picked up by the pneumatic returns pump and pumped back to the separating tank, whence, and synchronously, it recycles to the projector.

The actual cleaning of plates, members, coils, etc., is effected by the combination of the detergent jet impingement velocity and

Heavy Fuel Oil Tank bulkhead and flanged pipe, oil free and dry after cleaning. Note clean screw threads — no wiping of any kind employed.

Tank Cleaning Dangers—continued

the action of the detergent which breaks down the interfacial tension.

The hot detergent when projected on bottom accumulations, effectively liquifies them so enabling the returns pump to deal with them.

All parts cleaned by this system are oil free and dry, ready for repair and welding work or survey without any swabbing or wiping.

The condition of pipes and rivets, and the disclosure of pitting on plates, are to be seen in the accompanying photographs.

The Cost.

The cost in man-hours and materials is a small fraction of the cost of existing procedures. Briefly, the total steam consumption for operating four projectors, including heating and re-heating and supply to detergent pump, is about 1,000 lbs. per hour, the air consumption is about 20/25 cubic feet of free air per minute compressed to 45 lbs. per square inch, and the initial detergent cost about £20, the whole of which is recovered and available for further operations.

The time of the turn-round of a tanker or vessel requiring the cleaning of double bottoms is reduced very materially and the plant can be installed either as permanent equipment on a tanker and operated at sea, or on a cleaning barge, or on a mobile trailer ashore.

The initial cost of the plant, assuming steam and air are available, should not exceed £1,200 for a 4-projector equipment, or £1,800 for double this capacity. The cost of maintenance is low, and the saving of two days in the turn-round of a tanker would pay for the entire cost of the equipment.

The system is equally applicable to land installations and road or rail tankers, being capable of dealing with all mineral and fatty oils, industrial oils and tars. Variations in the specification of the detergent are made for special heavy materials such as tar, but the normal detergent specified meets the major range of applications.

Middlesbrough Dock Improvement Scheme

The Docks and Inland Waterways Executive, with the approval of the British Transport Commission, are to undertake an improvement scheme at Middlesex Dock at an estimated cost of £470,000. To meet the requirements of shipowners and traders, No. 10 Quay—hitherto used exclusively for shipping coal—is to be developed for general cargo working by the provision of two single-storey transit sheds, ten level-luffing electric cranes, and ample rail and road access. The scheme also provides for improved facilities, including a new road, at No. 2 Quay. The commencement of the work is subject to the approval of the Minister of Transport.

The principal features of the scheme are as follows:

No. 10 Quay.

(i) Two single-storey transit sheds, each with a loading bank 10-ft. in width, on the landward side, with two railway lines and with road access.
First Shed—385-ft. in length, with a width of 75-ft. for the first 350-ft. and 60-ft. for the remaining 35-ft.
Second Shed—350-ft. in length, with a width throughout of 75-ft.

(ii) Four countersunk railway lines on the waterside, 15-ft. gauge crane track and necessary capstans and fairleads.

(iii) Roadway 30-ft. in width at rear of transit sheds to connect with road to be constructed from Scott's Road, the roadway to be extended along No. 9 Quay.

(iv) Re-arrangement of railway sidings at rear of new road.

(v) Ten electric level-luffing portal quay cranes of 65-ft. radius, eight to have a lifting capacity of 6/3 tons and two of 10/5 tons.

No. 2 Quay.

(vi) Roadway 20-ft. in width, to connect with Scott's Road.

(vii) Countersinking of railway lines and crane tracks.

Pending the carrying out of the main scheme, an open general cargo berth is being provided at the eastern end of No. 10 Quay by the provision of rail and road facilities, the concreting of the quay surface and the transfer of four cranes from other parts of the dock.

Manufacturers' Announcements

Holophane Blended Lighting

A range of Holophane twin blended lighting units employing both mercury discharge and filament lamps has been designed for industrial installations where high standards of illumination, good colour quality and economy in operation are particularly desirable. By embodying the mercury and filament light sources in the one composite unit not only has a colour quality approaching daylight been obtained but disconcerting two-colour shadows have been largely eliminated.

In these Holophane twin lighting units, the individual light distributions of the mercury and filament reflectors are carefully matched, this factor being important in obtaining good colour uniformity in the blended light. The adoption of twin units in large installations has shown that there is an increasing demand for blended lighting in industry.

A New Heavy-Duty Flooring

A revolutionary type of heavy duty flooring which is claimed to have many advantages is now being marketed by Stelcon (Industrial Floors), Ltd. This product affords a means of laying down a very strong floor quickly and simply, the only requirement being a bed of sand evenly compacted over topsoil as a foundation. The Stelcon rafts measure 6½-ft. square and weigh approximately a ton; they are doubly reinforced throughout, bounded by angle iron and have a steel clad wearing surface. In order to lay such a floor, a detailed drawing is produced of the floor area and special rafts are manufactured to fit between rails and other fixtures. Once laid, these rafts have proved their ability to withstand very heavy traffic and weights. This is demonstrated by a Stelcon floor, which is subjected to a daily traffic of 180 Sherman tanks, each weighing

Stelcon Steel Clad Rafts in use on the Quayside at Rotterdam.

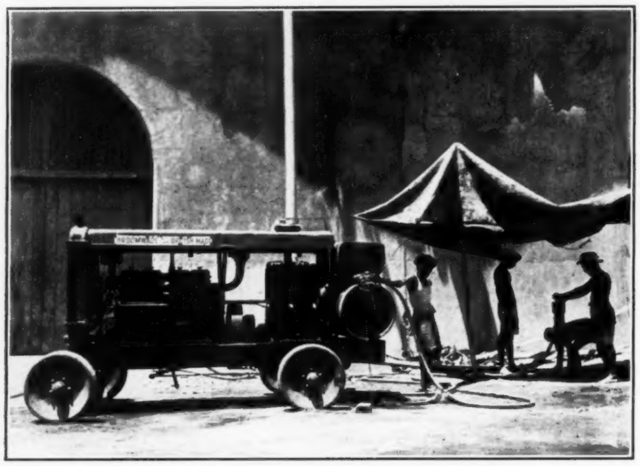
42 tons. The speed of construction of this type of flooring has a great advantage in that it can be subjected to heavy traffic immediately it has been laid; thus expediting and facilitating future work. The rafts are handled quite simply by a small crane or fork lift truck. Two bolts can be slotted through the four inch slab for quick movement and easy handling by crane. Over 500,000 square yards of Stelcon Steel Clad Rafts have been laid since the war, in docks and factories, including the docks at Rotterdam and Amsterdam. A further feature is the low maintenance cost of a Stelcon Raft Floor.

Manufacturers' Announcements—continued

British Compressors at Asian Ports

In modern ports and shipyards there is always a demand for compressed air for a great variety of purposes—for riveting and scaling hammers, and many other pneumatic tools used in the construction and repair of ships, as well as for general workshop purposes, and the maintenance of dock structures, rail tracks and roads.

British compressors, renowned for their reliability under exacting conditions, are widely used throughout the principal ports of Asia. The "Broomwade" portable sleeve-valve compressor shown here in use at the Port of Colombo, Ceylon, is an SV 199 with Lister diesel engine delivering 167 cu. ft. free air per minute, and is being used with a "Broomwade" pneumatic breaker in



Broomwade Compressor with Lister Diesel Engine in use at the Port of Colombo, Ceylon.

the port premises for breaking up stone setts and concrete road surfaces. This particular compressor has now given 12 years' service under the arduous climate of this Asian port.

In the Bombay shipyard of the Mazagon Dock Company, five other "Broomwade" portables are in use as stationaries, all but one having had their wheels and axles removed. Whenever they are required for other duties elsewhere on the premises they can of course easily be refitted with their wheels if necessary. All five machines are of the type SV 303 (250 cu. ft. models with Gardner diesel engines) and pump into a large boiler which has been adapted for use as an air receiver. Shipyards often have old boilers available, and having been constructed as pressure vessels they make excellent receivers for large quantities of air.

The photograph from Colombo is reproduced by courtesy of the "Broomwade" Agents in Ceylon, the Colombo Commercial Co. Limited, Slave Island, Colombo; their Agents in Western India are Messrs. Volkart Brothers, Graham Road, Ballard Estate, Bombay.

Revolutionary Lifebuoy Light

A new lifebuoy light produced by Messrs. Venner Electronics Ltd., of New Malden, Surrey, will, it is hoped, make an important contribution towards safety of life at sea. Unfailingly reliable even after standing idle for years without attention in all climatic conditions, the lamp is strongly constructed of Parkerised rust-proof steel, the buoyancy being provided by a specially moulded Onozote body. The special water activated battery is housed in a hermetically sealed container at the base of the buoy, while the lamp itself is protected by an unbreakable hood of clear plastic.

The unit is attached by a line in the normal way to the lifebuoy. When this leaves the chute it drags the lamp from its bracket tearing away a soft soldered strip from an orifice just above the battery compartment. As soon as the lamp hits the sea, water enters this compartment and activates the battery within a few seconds.

The special Exide battery, evolved by technicians and chemists of Chloride Batteries Ltd. to replace the dry cells normally used in this type of lamp, is based on an entirely new method of cell design and construction. It consists of a number of dry charged plates housed in an open-ended plastic container of square section. When these come into contact with water, either salt or fresh, the battery is energised almost instantaneously and begins to operate. It is designed to have a capacity sufficient to keep the lamp burning for a period of at least six hours.

Although possessing many of the characteristics of the standard dry battery (it cannot be re-charged and is, therefore, replaced after each emergency) the new battery offers many advantages for duties of this kind. Inexpensive and easy to produce, it is completely inert whilst protected from moisture and remains unaffected by wide variations in temperature. It can be stored indefinitely without risk of deterioration.

Chlorinated Rubber Paints Memorandum

Chlorinated Rubber Paints have been in general use in this country for some years and it is therefore surprising that their value, particularly in combating alkali, acid and severe corrosive conditions, is not as widely known as might be expected.

To provide further information on their various properties and uses M. W. Heilbrun, B.Sc., technical director of Allweather Paints, Ltd., 36, Great Queen Street, London, has written a comprehensive memorandum which should prove of interest and value to many readers of this Journal. Copies of the memorandum are available on request, and can be obtained upon application to the above address.

Fork Trucks for Rough Conditions

Mathew Bros. of Wallington, Surrey, are one of the few manufacturers in this country who produce a fork truck capable of travelling anywhere; either in narrow aisles in a palletized factory store, or, at the other end of the scale, over fields and moors. The value of the fork lift truck is well known, but it is not so generally appreciated that the principle of a truck with an elevating front mast is adaptable and can be utilized to lift and transport all kinds of awkward non-palletized loads over all kinds of terrain.

Matbro 2-ton Truck.

Many handling problems arise in fields and open stockyards, on farms and construction works, but until comparatively recently the fork truck was not applied to such jobs and has been developed primarily for inter-departmental factory work on smooth surfaces. A truck of this type is able to solve many of the handling problems met with "in the open," just as in factories, providing the truck has been adapted accordingly to manœuvre on rough ground.

Mathew Bros. are widening and developing their range, so that a load can literally be picked up anywhere and conveyed anywhere. The illustrations show two of this firm's current models; alternative attachments for these fork trucks include shovel, fixed jib, boom and dozer blade, which enable the trucks to carry out successfully almost any handling job.

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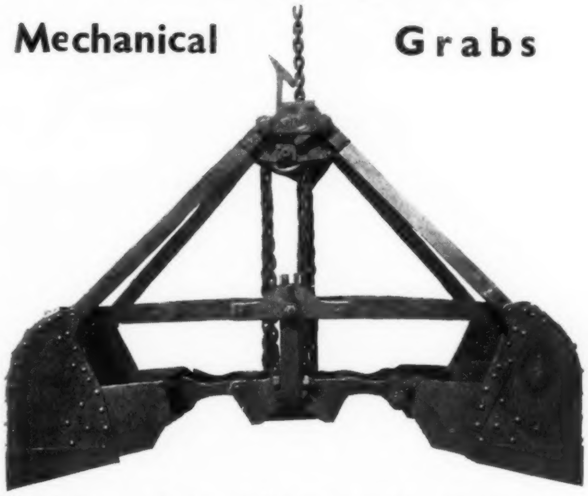
Mechanical Grabs



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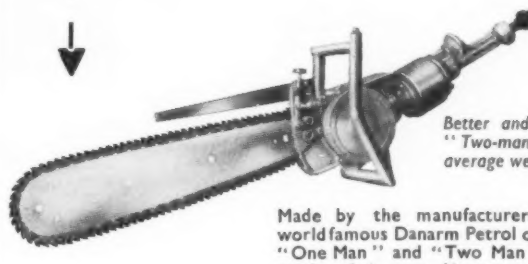

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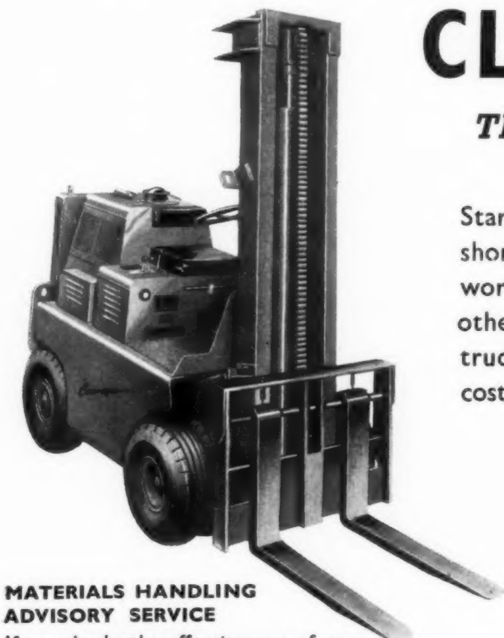

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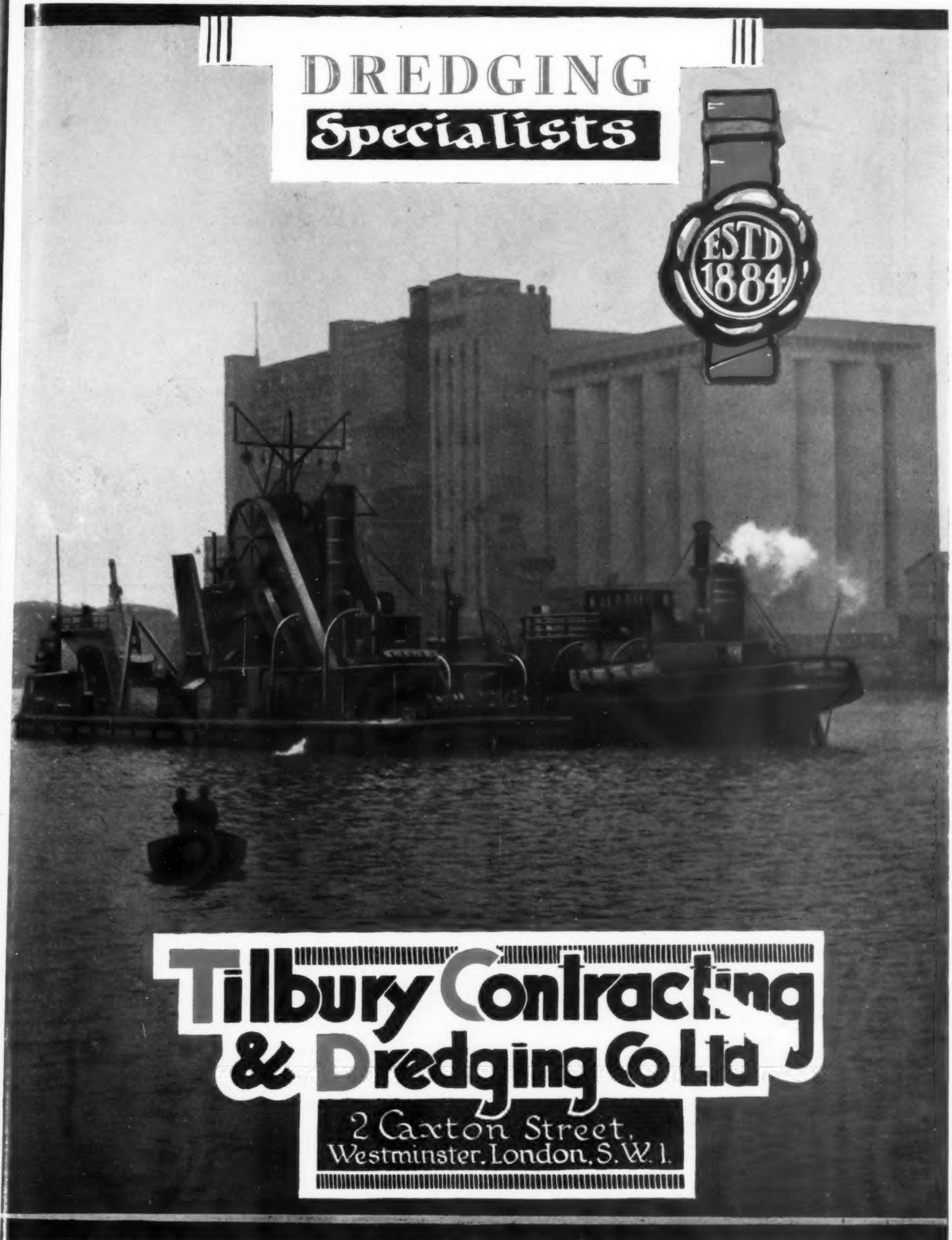
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